THE

AMERICAN NATURALIST.

VOL. XIII. — *SEPTEMBER*, 1879. — No. 9.

BRAZILIAN CORALS AND CORAL REEFS.

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OUR first accurate information regarding the character and extent of the Brazilian coral reefs, as well as of the sandstone reefs, dates from the earlier explorations of the late Prof. Hartt in Brazil. Prior to the publication of his general work, referred to in the June number of this journal, there existed only a few imperfect notices of corals and coral banks on the Brazilian coast. Spix and Von Martius, during their South American travels in the early part of this century, discovered patches of living and dead corals at several localities along the sea coast of Bahia, but they did not stop to fully investigate them or extend their observations, and the corals they collected were erroneously referred to old Lamarckian species.

Darwin, who touched at the Abrolhos islands, saw corals growing upon the shore, but overlooked the vast and curious reefs that occupy so much of the surrounding region. On the authority of others, however, he states that around these islands "the bottom of the sea is entirely coated by irregular masses of corals, which, although often of large size, do not reach the surface and form proper reefs." In this he was partly right, but very largely wrong, as we shall see farther on. Darwin also refers to coral reefs at Maceio and Pernambuco, and Prof. Dana mentions a reef near the latter place. Other observers had increased the number of localities where coral reefs occur, so that when Prof. Hartt began his studies of these structures, we were already acquainted, in a general way, with a line of scattered, and often widely separated, coral reefs and banks extending from the Abrolhos islands northward to Maranhão. Our information respecting them was,

however, very meagre, and usually unreliable. Only a very few species of Brazilian corals were known, and these were mostly Gorgonians from the bays of Bahia and Rio de Janeiro.

The sandstone reef and coral reef regions of Brazil are nearly coëxtensive, but while the stone reefs are always confined to the immediate neighborhood of the shore, coral reefs frequently lie some distance out, at times forty or fifty miles. It was while investigating the stone reef at Porto Seguro, in 1866, that Hartt's attention was first attracted to the coral reefs, one of which stretches across the mouth of the bay of Porto Seguro, in front of the sandstone structure. This reef was carefully studied, and growing upon it were discovered all the commoner Brazilian corals. A year later Prof. Hartt visited the Abrolhos islands, for the purpose of examining the many reefs that cluster about that little group of Continental islets. The trip was a very successful one, resulting in the discovery of new and interesting phenomena in connection with the formation of coral reefs. Many corals were obtained, including all the species previously found at Porto Seguro, and these constituted the first large collection of Brazilian corals to be properly studied and described. The work of classifying this material was entrusted to Prof. Verrill, of Yale College, who decided that nearly all the forms were new to science.

Prof. Hartt's studies on the Brazilian coast have proved that Madreporian corals grow abundantly on or near the shore, from Maranhão southward to Cape Frio; south of which only a few Astrangians have been collected. Coral reefs are, however, more restricted in their range, as they do not pass to the southward of the Abrolhos region. Just to the east of the Abrolhos islands, between these islands and the mainland, and thence northward to near the city of Bahia, coral reefs are very numerous, often fringing the shores, but more commonly growing in large and irregular patches in the deeper water. From Bahia to Maranhão coral reefs are much less abundant, being confined to certain localities near the shore. The Roccas, between Fernando de Noronha and the coast, are, however, entirely of coral. The Brazilian coral fauna is very poor in species, but, as far as it goes, closely resembles that of the West Indies, many of its species being representatives ones. A large number of the commoner West Indian genera, such as Madrepora, Mæandrina, Diploria, etc., are wanting to Brazil.

Having thus briefly defined our present knowledge of Brazilian corals and coral reefs, let us proceed to study them more in detail, as they appear to one traveling through the regions in which they are contained.

Rocky shores, although usually of a tame character, are not uncommon in the coral region of Brazil, and they afford a proper footing for the growth of corals, both as scattered masses and in the form of reefs. The Bay of Bahia has quite a rich coral fauna, and presenting a varied shore enables us to study well the several littoral and shallow water species. As we enter the bay through its broad mouth, high cliffs of gneiss stand up before us on the right, but they soon give way to a low, and often nearly level shore of Cretaceous shales, sandstones and conglomerates, which, interspersed with beaches of sand, border almost the entire bay. Long stretches of rock lie under the influence of the tides, being entirely covered during flood, and exposed at low water. In addition to these, countless ledges exist everywhere off the shore, and being always submerged are better suited for coral life.

In the many tide pools of the rocky surfaces, and just below the level of low tide, live in abundance two of the most common of the Brazilian corals, *Siderastræa stellata* and *Favia gravida*. These two species are almost always associated together, and they range throughout the entire coral region above defined. The former is, however, the more abundant, and attains the larger size; it is also the more hardy species, and at low tide may be exposed to a burning sun for an hour or more without sustaining injury. The size and shape of these coral masses, as well as the general structure of their cells, often vary greatly, according to the kind of rock on which they grow.

If the shore be formed of shales, presenting a level surface but affording only an insecure attachment, the corallum will spread outwards rather than upwards, giving rise to a thin flattened mass which may be over a foot and a half across and less than an inch thick. A smooth sandstone surface gives a firmer foundation, and permits, as it were, a thicker growth, although the tendency is still toward lateral spreading. Shores of gneiss and conglomerate are, however, generally rough and jagged, pierced with irregular holes and beset with multitudes of rounded or angular projections. On such a surface the growth of flat and level coralla is impossible; they tend to rise in hemispherical or globular

masses, conforming more or less in size and shape to the projections from which they spring. This law of variation seems to hold good for the entire coast. A small species of Porites occurs at times, associated with the two species above named.

A little deeper down, where they can seldom, if ever, be uncovered by even the lowest tides, come in other and more showy corals. Mussas grow profusely at many localities, seeming to prefer the abrupt outer edges of the submerged rocks. They belong to two species, one with separated cells not now living in the Bay of Bahia, the other having the cells closely joined nearly to their summits. Occasionally we find small heads of Orbicella and Acanthastræa in similar situations, but these more commonly inhabit deeper water. The same may also be said of Millepora, the hydroid coral, of which there are two common and one rare species on the Brazilian coast; in very shallow water it is stunted in growth and usually bears only short branches. Living on the under sides of stones, in company with encrusting bryozoans, is a very small Astrangian, consisting of many widely separated cells united by thin creeping stolons.

An Agaricia, very rare in the Bay of Bahia but more common elsewhere, generally grows attached to some other coral, as, for instance, to the dead base of Mussa. On the coast of Pernambuco there is also a small Stylaster attaching itself in the same way. *Pectinia braziliensis* is seldom found adhering to a rocky surface, but is very abundant at times in sheltered situations, partly buried in the mud. There remains only a single other Madreporian coral to mention here; it is the *Porites solida*, which seems to live nearly everywhere excepting in the Bay of Bahia.

This closes the list, with one or two exceptions of rare species, of the shallow water Madreporian corals of Brazil. The most of the species enumerated are very widely distributed, ranging along the entire coast north of Cape Frio. But they are not confined to the shore, for the majority also occur on the outer reefs, which are, so far as we know, entirely built up of a few of these same species. From depths ranging from twenty-seven to forty fathoms were procured several small corals; but these forms can, at the most, play only a very insignificant part in reef-building.

Let us return, however, to our studies in the bay. Five or six species of Gorgonians are abundant nearly everywhere, growing as commonly from small stones and dead corals imbedded in the

sandy and muddy bottoms, as from the rocky surfaces which afford them a more secure foundation. Two or three additional forms have been found along the coast; but the soft nature of these corals does not permit of their entering into the structure of a reef, excepting as their minute spicules may be added to the calcareous sand or mud, a very important element in the formation of coral reefs.

We pass now from the corals proper to other organisms, that give rise to quite as durable a substance of the same chemical composition. These are among animals the Serpulæ and Barnacles, and among plants the Nullipores. They grow abundantly on the shore, forming encrusting layers or thickened masses; but we have treated very fully of these forms on page 352 of this journal, in connection with the sandstone reefs. The thin encrusting nullipores, with nearly smooth or slightly mammillate surface, which cover so much of the Pernambuco reef, inhabit also many of the rocky shores, but are more abundant over several of the coral reefs that have reached too high a level for the growth of true corals. There is another common nullipore, composed of many intermingling and closely placed branches, which project outwards in all directions as numerous digitations. This form grows to an immense size at times, and is associated with the corals in reef-building. A coarsely jointed coralline forms large and dense clusters on the coast of Pernambuco, and its detached segments sometimes form quite a thick deposit, especially on the surfaces of reefs.

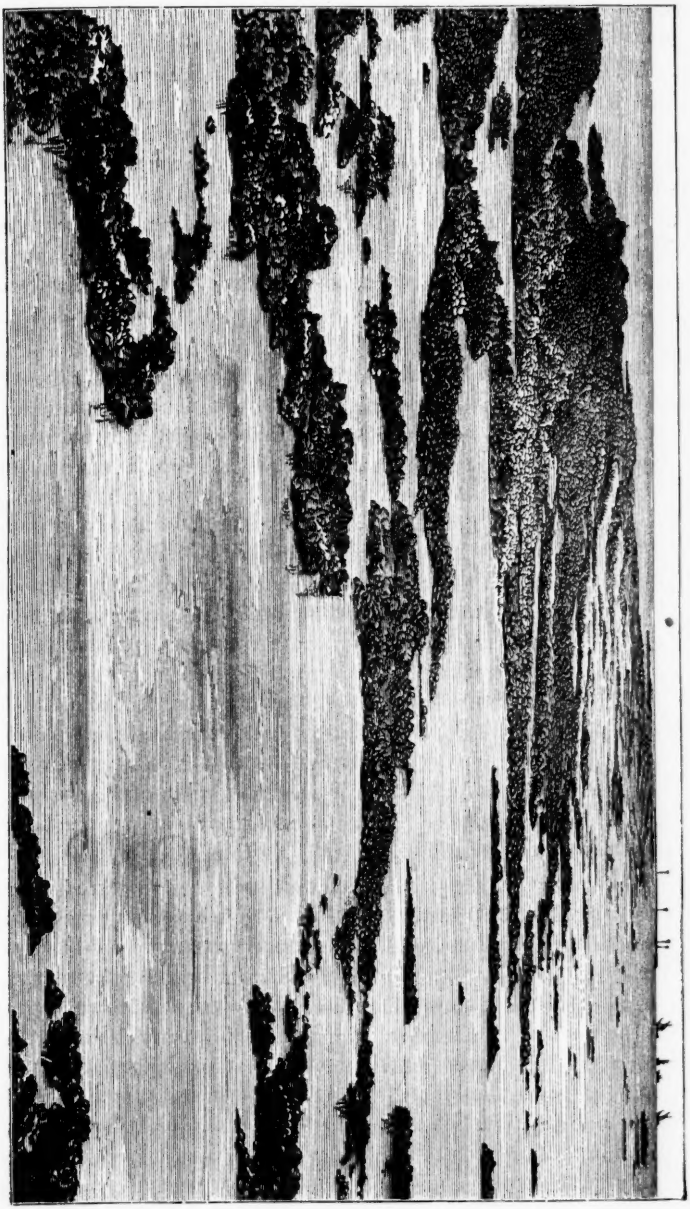
The limestone-producing fauna and flora we have thus hastily reviewed, may not differ in their essential features from those of all the other coral regions in the world, but it has seemed best to treat of them as fully as we have, in order to show more clearly how few are the species of Brazilian corals, particularly those that can aid materially in the building up of reefs. Up to this time but thirteen species of Madreporian corals, representing ten genera, have been found on or about the Brazilian reefs, and of these only three or four ever attain to any considerable size. Millepores have also contributed largely to the coral reefs.

We have now to trace the gradual variation in coral growth as we proceed outward from the shore toward the reef grounds. Here is a rocky ledge, reaching to within about a fathom of the surface at low tide. It is of small size, only a dozen feet each

way, but it affords a good base for corals to grow upon, and the ebbing and flooding of the tides produce about it a constant current of the purest sea water. No locality could be more favorable for marine life. As we approach in our canoe, the first objects that appear are the millepores, sending upward from their shapeless bases the most irregular and fanciful forms, generally in the shape of broad leaves or of ramifying branches ending in finger points. So wild and luxuriant is their growth at times that they partly cover up and obscure the lower-lying heads of more solid corals. But scattered everywhere between them, and over the edges of the ledge, are huge heads of Orbicella, Acanthastræa and Siderastræa, while Mussas and Porites also occur. Other of the shore corals are there too, but from their small size escape our notice in this hasty examination. We see only those larger forms that stand prominently forward, and thus proclaim their great importance in the building of durable structures that may last for all eternity.

This little group of corals, surmounting the rocky ledge, forms a miniature reef; it has only to build upward as far as the water will allow, and fill in the open spaces either with additional growths or with hardened coral sands to possess a true reef structure. Now prolong the ledge with its living top; let it stretch away for several miles and be broadened out to as many yards, and we have a reef such as occurs at times on the Brazilian coast. Unless the coast is sinking the reef soon attains its height and ceases to grow on top, but it may still continue to increase in width. Several of the Brazilian reefs are exactly of this character, having very little height, but from the surface looking like very massive structures. A broad area, presenting favorable conditions for growth, sometimes results in the formation of a wide and irregular coral bank, but such are not common near the shore.

We might now enter into a discussion of the many fringing and other reefs that lie along the coast; but they are all more or less repetitions of one another, are formed in similar ways, and composed of the same corals we have been describing. They are very many in number, occurring in all favorable localities, especially on the coast of Bahia, south of the capital. There is one reef, however, that derives a special interest from the accurate view of it we are able to give, and having been partially raised



Coral Reef of Bay of Bahia.

above the water its growth is nearly finished, so we can trace its entire history from the beginning to the close.

The long island of Itaparica, often called the garden of Bahia, fills up almost the entire south-western quarter of the large Bay of Bahia, and contracts its entrance to a width of about five miles. Its outer coast, running obliquely, faces for the most part the open sea, and is at the mercy of its boisterous waves. Skirting the central portion of this coast for a distance of nearly nine miles, is a slightly elevated coral reef, long since abandoned by true living corals and given over to another class of workers, who are putting on the finishing touches and coating it with a hard and durable substance.

This reef begins directly opposite the city of Bahia, in front of a little rocky point named Jaburú, and stretches away southward, in the general trend of the shore, enclosing behind it a narrow and shallow channel which, at the most, is scarcely one-fourth of a mile in breadth, and generally less. It is most perfect toward the northern end, and has, at irregular intervals, numerous breaks or openings which admit the smaller boats that ply along the shore. Approaching close to Peña, another rocky point about three miles from Jaburú, it ends abruptly; but commencing again just to the south, it runs onward to the Ponte da Cruz, terminating for good on the rocky shore. The study of the geology of the island has shown that the reef follows the submerged, outcropping edges of a series of heavy beds of sandstone, which, at times, bring up on the shore in the form of rocky points. On this solid base the reef appears to have been built, and where, finally, at the south, the sandstone leaves the sea and lies upon the beach, the coral reef ceases to exist.

The reef is slightly zigzag in its course, and both edges are very jagged, deeply indented and bordered by projecting or outlying masses; but so irregular is every part that it would be quite useless for us to try and describe it accurately. At the northern end it is generally elevated on the outer side and low and level on the inner. The higher portion varies greatly in width and height, and is never flattened on top; it rises rapidly, often abruptly, from the water, but descends more gradually on the inner side to a level of about one foot above ordinary low tide. From here there extends inward a very flat surface, which is generally quite broad but may narrow down or even nearly disappear.

Almost everywhere along the inner edge, but more commonly at the ends of the reef and about the openings through it, we find many outlying masses which are often partly continuous with the low, inner surface, but more frequently quite detached. They attain all heights up to that of the lower surface, but never reach above it; the average depth of water around them is between three and four feet. The outliers on the outside of the reef are merely low, ragged, angular projections from the reef itself, and are never much exposed, even at low tide.

Between the two divisions of the reef, the elevated outer portion and the flat inner one, there is the most marked contrast. While the latter has been completely smoothed and rounded off, so that scarcely any angles remain upon it, the former retains all the possible roughness that could be brought together on so narrow an area. The entire raised mass of rock is full of holes of every imaginable size and shape, the margins of which are always acutely angulated. Every little surface that is not pointed in itself is surmounted by a large and strong barnacle with sharply-edged valves, and large clusters of digitate projections stand up at frequent intervals. This combination of surface is a very uninviting one to look upon, but it is far less pleasant to climb over it or walk along its upper part. The outer slope is by far the most irregular, as the waves, aided by an army of sea-urchins, have broken into it and hollowed out thousands of ragged holes, which, lying concealed beneath the seaweeds, might lead to many accidents were the reef more frequented.

The outer portion of the reef is of a dark and rather rich brown color when wet by the waves, but nevertheless has quite a dead appearance. Examining carefully this brown rock, it is seen to consist generally of an accumulation of very small worm tubes, closely packed together and forming a very hard mass. The surface of the low inner level is of a much lighter color, a rather faded brown, and looks even more lifeless than the part we have been describing; no barnacles or other large animals grow upon it.

What forms of life occur about the reef? On the outer side, reaching to a height of a foot or slightly more above ordinary low tide, is a luxuriant growth of seaweeds. Over the same zone, but not so apparent, spread encrusting nullipores, which, though resembling lichens in form, are so highly charged with lime as to

produce a hard coral-like substance. This is one of the most important organisms living on the reef at present, and while aiding to protect it from wear is also building it up. The barnacles and worm tubes of the upper portion we have already referred to, and we have also stated that over the inner surface there seems to be nothing alive. As we enter the many open pools and passage ways of the inner margin there is scarcely more to be seen. Only here and there does a small mass of coral grow, usually a Siderastræa or a Favia. Seaweeds and delicate tufted hydroids and bryozoans hang from the sides of the pools, and a few shell-fish and star-fish lie on the sandy bottom. Small, brilliantly-colored fish dart hither and thither, but the life is not what we are taught to expect about a coral reef.

The features we have so far been giving are those of the northern section of the reef. Going southward a short distance, the elevated outer mass gradually diminishes in size, until it is reduced to a slightly raised border along the seaward margin of a broad and flat reef. Still farther south the entire lower surface, without the raised margin, seems lifted bodily upwards to form a high massive wall, like that of an immense fort, flat above and perfectly square at the sides.

Between the points of Peña and Cruz we find a varied structure, generally, however, only a repetition of the forms already described. The reef is often two or three times as broad as at Jaburú, but near its southern end it becomes very irregular and much broken up, existing as a line of detached reef masses. The passage ways through the reef are sometimes mere simple breaks, cut as squarely and neatly as though the work of man; at other times, however, the edges of the reef bordering them are carried obliquely inwards some distance toward the beach, enclosing a narrow entrance channel. These inner prolongations, although generally low and level, have the same structure as the main reef.

Within the reef the water is always shallow; frequently the bottom lies so high as to be quite exposed at low tide, and it is covered nearly everywhere by a thick deposit of coral fragments, cemented together by carbonate of lime. The corals are not in place but lie heaped together in every conceivable way, as though they had been violently broken from the reef at some former time and thrown inside by the waves. All the commoner forms are there, Millepora, Siderastræa, Orbicella and Mussa being the

most conspicuous, and they are sometimes nearly perfect, but most often broken into irregular masses, large and small. The majority are also coated over with a thin nullipore crust, as though they had been dead a long time before they were swept from their proper dwelling places. This coral deposit has considerable thickness near the middle of the channel and thins out gradually toward the beach.

The extreme southern end of the reef is very low, and near to the beach. It breaks down abruptly on the outer side, but on the inner is bordered by a thick, consolidated layer, which reaches so nearly its own level that it is often difficult to make out the dividing line between the two. A close examination, however, discloses the upright corals in the one and the prostrate fragments in the other.

A great difficulty stands in the way of our determining the intimate structure of this nearly extinct reef, whose outward appearance and surroundings we have so fully discussed. It has evidently not been formed entirely by those agents at present occupying its upper and outer surfaces; but the remains of the real builders, whatever they were, are now entirely covered up and hidden from view, excepting at the one point at the southern end just mentioned. We must resort to artificial sections, no easy undertaking in a coral reef.

Breaking with hammer and chisel into the higher part of the reef, we obtain specimens of a very hard, compact limestone, partly of a nearly homogeneous structure, partly marked by straight or wavy lines of lighter and darker coloring; these two kinds of structure are intermingled with one another without order, sometimes one, sometimes the other predominating. The former has resulted from the masses of serpula tubes—by the complete filling in of their winding cavities and the spaces between them by carbonate of lime, until no trace of the original structure remains. The latter is due to the growth of incrusting nullipores, one thin layer upon another, until quite a thickness of rock has been the result.

It is evident that serpulæ and nullipores were at one time living together over the surface of the reef, and by their combined action has been formed most, if not all, of its outer raised portion, which is sometimes over four feet high and twenty-five feet across. The barnacles are generally broken from the reef when

dead, but are sometimes overgrown by worm tubes and thus become imbedded.

Here and there, the slaves in procuring limestone, have quarried into the low inner part of the reef, and even into the high wall-like portion. Good sections for study are thus formed, and they tell us of what the reef consists. Many large heads of Orbicella, Acanthastræa and Siderastræa stand there exposed in their original positions, and when cut through show their structure to be as open and perfect as though they were still living. With them are many large millepores and nullipores, and all the intervening spaces are filled in with a compact calcareous substance.

Our structure began as a true coral reef, stretching along the submerged rocky ledge. The water was very shallow, however, and the reef soon reached a level above which its corals could not live. Over them nullipores began to grow, but probably while the reef was being raised by other causes than those of growth, large numbers of these dead and partly entombed corals were swept inward by the waves. Nullipores continued to thrive and serpulæ came in to aid them, but with these forms we are already familiar.

Under certain conditions corals begin to grow in scattered patches over the sea bottom, and build up columnar masses which may eventually reach the surface. These columns vary in diameter from two or three feet up to several yards; they are very irregular on top, and covered with living corals. Such structures frequently occur near the shore, generally along the margin of a fringing reef; but their true habitats—where they are best developed—are in the deeper waters of the Abrolhos region, and between there and the city of Bahia. They have also been recorded from Florida and other parts of the world, but on the Brazilian coast they are a much more prominent feature, composing nearly all the larger reef patches.

As one of these coral pillars approaches the surface of the sea, the tendency to upward growth is necessarily destroyed, and the corals living only at the sides build out a rim about it. A mushroom or umbrella-shaped structure, called by the Brazilians *chapeirões*, or big hats, is thus produced. If many such chapeirões occur near together, their ever enlarging rims finally meet, resulting in the formation of a connected reef surface, supported by many upright pillars underneath.

Prof. Hartt, in his "Geology of Brazil," already quoted, has

very fully described the various Brazilian reefs formed by chapeirões, and there is little new to add; but we will take a hasty glance at them in order to complete our sketch. The Abrolhos islands lie some forty miles from the coast, near the middle of the submerged continental plateau, in about latitude 18° south. Surrounding them is a very extended area of constantly warm and pure water, everywhere less than a hundred feet deep. Just to the eastward of these islands is a region, nine or ten miles long and about four broad, over which the pillar-shaped structures are thickly scattered, forming the well-known *Parcel dos Abrolhos*. The chapeirões occur here of all heights and sizes, but never reach the surface, or coalesce to form a continuous reef.

To the north-west of the Abrolhos, and reaching much nearer to the mainland, is the largest reef region of the Brazilian coast, called the *Parcel dos Paredes*, or *Shoal of the Walls*. It is irregular in outline, being about seventeen miles long from north to south, by about nine miles broad in the widest place. Within this area are extensive connected reefs, as well as multitudes of scattered chapeirões. The northern part of the Parcel forms one immense reef, reaching slightly above the level of low tide and formed by the growth of large coral patches and by the coalescing and filling in of chapeirões. This latter feature in reef building has been noticed only on the coast of Brazil. The edges of the reef are very irregular, but the upper surface, laid bare at low tide, is of quite uniform height, although marked by many scattered shallow pools. Running along the margin of this level portion, and separating it from that which is constantly submerged, is a slightly raised border, a foot or less in height, formed by the growth of nullipores, serpula tubes and barnacles. At low water the waves beat against this hard rim, which thus helps to protect the upper part of the reef from wear. The submerged border of the reef dips gently for a certain distance, and then breaks down abruptly to a depth of three to ten feet, meeting a bottom of soft, bluish, calcareous mud which slopes rapidly away, soon attaining a depth of seventy to eighty feet. Chapeirões surround much of this large reef, and extending off southward from it, form two other reefs, the *Recife de Leste* and *Recife da Pedra Grande*, comprising the rest of the *Parcel*.

Several other reef patches, resulting from the growth of chapeirões, occur between the Abrolhos islands and the mainland, and also farther north along the coast of Bahia.

THE FORMATION OF CAPE COD.

BY WARREN UPHAM.

[*Continued from August Number.*]

ON Cape Cod, as on Long Island, Martha's Vineyard and Nantucket, we find, south of the line of morainic hills, an area of modified drift in extensive plains which slope very gently southward. These are fully ten miles wide from north to south in Sandwich, Falmouth and Mashpee, and thence to the east they have an average width of five miles. From the south-west limit of this area at Falmouth village, the traveler who follows the road along the south side of the cape through Waquoit, Cotuit, Hyannis and the south villages of Yarmouth, Dennis and Harwich, sees only level plains twenty-five to forty feet above the sea, with occasional hollows and valleys, most of which are occupied by ponds and brooks. No boulders are seen in this distance of more than thirty miles. They occur, however, in the small hills west of Hyannis harbor, the highest of which is eighty-one feet above the sea, and in lower mounds and ridges two and a half miles south-east at Point Gammon. Shoals of boulders, known as Collier's Ledge and the Bishop and Clerks, lie three miles off shore opposite to these points. Chatham and Orleans, at the east end of this area, are also modified drift, but its surface is very irregularly moulded into hills, ridges and enclosed hollows, the highest elevations being about one hundred and twenty-five feet above the sea. The north edge of this area, next to the terminal moraine, consists of more elevated plateaus, fifty or seventy-five to two-hundred feet in height. From this line there is a continuous slope southward, scarcely perceptible but declining in the five to ten miles of its extent to within twenty-five to forty feet above the sea. This north portion of the plains is marked by frequent hollows of large extent, which contain ponds fifty to one hundred feet below the general surface.

A fine idea of the slope of this deposit of modified drift is obtained in a journey from Sandwich to Greenville, Ashunet pond and Falmouth. The ascent of two hundred feet or more from sea-level to the highest point of the road is accomplished in two miles, bringing us to a point on the road where Bourne's hill, the highest on Cape Cod, is within a half mile to the east, while close at the west is the Great Hollow, about one hundred feet deep and

perhaps a half mile wide, and twice as long from north to south. This is enclosed on all sides by the hills and high plains, but contains no water, showing that the plane of saturation is very deep; while copious springs at the north foot of the hills indicate that it falls in that direction. Without descending more than twenty feet below its highest point, the road next enters upon a plain of gravel and sand, and thence extends seven miles before crossing the first hollow, which is at Ashunet pond. Beyond this point it crosses numerous depressions that are or have been water courses; but there is no break in the continuity of the plains, which in about twelve miles descend by a gradual slope from the height of two hundred feet to sea-level.

These plains of Cape Cod are further like those of Long Island, Martha's Vineyard and Nantucket in being indented by narrow arms of the sea, which reach one to two miles inland, filling the lower end of long depressions that continue across the plains to the north, being either dry or occupied by small streams.[1] The plains and valleys which thus generally border the terminal moraines on their south side appear to have been formed by the same floods which deposited the large amounts of modified drift along the edge of the ice-sheet. Much of their finer gravel and sand was carried forward by the descending currents, and spread in these gently sloping plains, while the valleys of drainage seem to have been made by the same waters at their lower stages.

The continuation of these valleys below our present sea-level calls up one of the most complex but at the same time most important and interesting questions connected with glacial geology. This feature shows plainly that when these valleys were formed the sea did not reach so high upon the land as now; and if we extend our inquiries we find that everywhere around the world the glacial period was marked by most extraordinary changes in the relative heights of land and sea. These remarkable oscillations, which had one extreme at the equator and the other at the poles, appear to have been changes in the level of the ocean. It seems not unlikely that an eighth part of the earth's surface had become covered with ice, and if we consider a slope of one-half a degree to be needed to give it motion, an estimate of four miles for its average depth does not seem to be too great.

[1] These valleys on Long Island have been described by Mr. Elias Lewis, Jr., in *American Journal of Science and Arts*, 3d series, Vol. XIII, pp. 142–146 and 215.

The removal of the water thus taken from the sea and stored up in accumulations of ice would lower the surface of the ocean more than a half mile. At the same time this vast accumulation of ice in high latitudes must draw the sea by gravitation away from the equator toward the poles. This cause appears to have retained the sea-level at about its present height near the lower limit of the ice-sheet, while in arctic regions it rose much higher than now. Marine shells in the modified drift show that the sea thus stood fifty to two hundred feet above its present height on the coast of New Hampshire and Maine; five hundred feet in the valley of the St. Lawrence, and one thousand to two thousand feet higher than now along the west coast of Greenland. Everywhere in high latitudes, both in the northern and southern hemispheres, we have proof of such a submergence of the land when the drift was accumulated, increasing in amount the nearer we go to the poles. On the other hand, the coral islands of the tropics are witnesses of the depression of the sea in this period, amounting to three thousand feet, or perhaps more, at the equator, while different evidence shows that at the mouths of the Mississippi, Ganges and Po rivers it was at least four hundred feet lower than now. If we reflect upon these widespread changes of sea-level that marked the glacial period, occurring only where they would be produced by taking water from the sea to form ice-sheets and by gravitation through their influence, and if we compare these recent simultaneous changes with the general stability of the continents, we seem compelled to attribute them to movements of the sea rather than of the land.

Because of the attraction of accumulations of ice that still remain about the poles, where probably little or none existed in Tertiary times and at the epoch immediately preceding the glacial period, the sea along the eastern coast of the United States appears to be lower now than during those periods, uncovering the Tertiary border of the Southern States and leaving pre-glacial deposits with marine shells, apparently Post-pliocene, fifty to two hundred feet above our present sea-level, under the terminal moraine and modified drift of Long Island. The entirely unstratified character which marks many portions of the terminal deposits of the ice-sheet, reaching quite to the sea-shore, and the still lower extension of the channels which appear to have been cut by the floods formed at its melting, indicate that at the south

coast of New England the sea was depressed in the glacial period below its present height. The submarine channel of Hudson river shows that after this time it sank five or six hundred feet lower than now, apparently because the south part of the glacial sheet had been melted, greatly diminishing its attractive force at this latitude. With the more complete departure of the ice the sea-level has been restored to approximately the same condition as before the glacial period, being still rising on the eastern coast of the United States at the rate of about a foot, or less, in a hundred years.

The channels which we have described as occurring on the plains that slope southward from the series of hills, are best shown on Cape Cod, in Falmouth and eastward to Cotuit harbor, which is the region directly south from the angle of the terminal moraine and from its highest hills, which in this portion of its course are composed mainly of modified drift; in other words, they occur most abundantly where the drainage from the melting ice-sheet must have been greatest, including all the floods poured down from the ice-fields along the line between Falmouth village and North Sandwich, those that converged toward the angle of the ice-margin, and those which brought down its vast frontal hills of gravel and sand along several miles eastward. Some of the hollows containing ponds, which are found frequently on these plains, may have been left unfilled because masses of ice remained there while gravel and sand were rapidly deposited about them; but probably in most cases they are due to unequal deposition, though with unobstructed drainage.

North and north-north-west from the angle of the moraine, a most irregular belt of kame-like modified drift in ridges, hills, plateaus and hollows of every shape, but generally with a north-to-south trend, reaches to Kingston, a distance of nearly twenty miles. These deposits are finely seen along the road from North Sandwich by Great and Little Herring, Bloody and Long ponds. The elevations are fifty to one hundred feet above the depressions, and one hundred to two hundred feet above the sea. The material is obliquely bedded sand and coarse gravel, with pebbles up to one foot in diameter. Boulders are rare or entirely wanting for some eight miles, till we reach Pine and Manomet hills, already described, which seem to constitute a medial moraine of coarsely rocky unmodified drift, accumulated by ice-currents without the agency

of running water. The descending slopes and consequently the currents of the ice on the east and on the west appear to have met here; and when the period of melting came, it was along this belt, extending from North Sandwich to Kingston, that the largest and most heavily loaded rivers flowed down from the departing ice-fields. A great part of their deposits of gravel and sand appear to have been laid down in channels and upon open areas which still remained walled by ice, but when this disappeared they remained in kames or ridges, hills and plateaus, with many enclosed hollows. Telegraph hill, about two hundred and seventy-five feet in height above the sea, and others seventy-five to one hundred feet lower, lying within two or three miles west from the south end of the Pine hills, are probably mostly modified drift, though overspread with frequent boulders up to ten feet in diameter. These are short parallel ridges, with a north-to-south trend, separated by hollows fifty to seventy-five feet below the crests. About Plymouth village the modified drift forms kame-like hillocks and small plains, which are separated by very irregular hollows and valleys. The tops of these deposits have a nearly uniform height, which varies from one hundred to one hundred and twenty-five feet above the sea. Two miles to the west is an irregular series of hills, resembling a terminal moraine, which reaches some three miles westward, varying in height from one hundred and seventy-five or two hundred feet to three hundred and thirteen feet at Monk's hill, in Kingston. Most of these appear to be unstratified boulder-drift, but the top and north side of Monk's hill are waterworn gravel and sand with only few boulders.

In the west part of Plymouth level plateaus and plains of modified drift prevail, broken by frequent hollows of small area with steep sides, containing ponds. These are so numerous that this township is said to have a pond for each day in the year. To the west and north the greater part of Plymouth county consists of similar nearly level or moderately undulating deposits of modified drift fifty to one hundred and fifty feet above the sea. These beds of sand and gravel cover the townships of Wareham, Carver, Middleborough, Plympton, Halifax, Duxbury, Pembroke, Hanson, Hanover, the west part of South Scituate and much of Hingham, reaching continuously from the angle of the terminal moraine of Cape Cod more than thirty-five miles north-north-westward to the

south shore of Massachusetts bay. None of the streams of this region can be supposed to have aided in the accumulation of these materials, instead of which they are evidently carrying away small portions as they gradually deepen and extend their channels. The origin of these plains seems to be due, like the kames of Plymouth, to floods and detritus supplied by the melting ice-sheet which sloped from both sides toward this area. The deposits made in the lower part of the channels of these glacial rivers, between walls of ice, remain as kames, or ridges and hills, composed mainly of coarse gravel, while the portion carried forward and spread beyond the retreating ice-margin forms the nearly level plains.

The only fossils found upon this area are within about a mile south-west from South Marshfield, and were encountered many years ago in digging wells at the houses of Messrs. Kent, Chandler, Wadsworth and Sprague, which succeed each other along a distance of one-third of a mile, the last being in the edge of Duxbury. All these wells showed a surface of modified drift ten to twenty feet deep, enclosing occasional boulders, underlain by a hard ferruginous stratum, six inches to a foot thick, below which were muddy silt, sand and fine gravel, containing successive fossiliferous layers, those at Mr. Chandler's well being four in number, twenty to thirty-five feet below the surface, at heights twenty-five to forty feet above the sea. The fossils include casts of the quohog, long and razor clams (*Venus mercenaria*, *Mya arenaria* and *Ensatella americana*), and numerous fragments of lignite. The iron-rusted stratum, varying in height from thirty to fifty feet above the sea, and extending continuously at least a third of a mile, seems to represent the depth to which the preglacial deposits were eroded by the ice-sheet, and the lower beds were probably contemporaneous with those at the base of Sankaty Head.

The extreme portion of Cape Cod, north from Orleans to High Head, consists entirely of modified drift. Boulders are very rare, but in two places seem worthy of notice; one of these is about a mile south-west from Nausett Lights, in Eastham, where an enormous boulder, called Enoch's or Great Rock, lies apparently half buried in the sand. The portion in sight is thirty-three feet long, twenty-five feet wide and fifteen feet high. Only two or three other boulders were seen here, none of them exceed-

ing five feet in diameter. The other locality is about a sixth of a mile west from Highland Light, where one block fifteen feet long and several others five feet long occur. In the north part of Eastham the modified drift forms extensive level plains about fifty feet above the sea. From South Wellfleet to High Head, in the north part of Truro, the contour on the west side of the cape is in very irregular small plateaus, ridges and hills, nearly uniform in their height, which varies from one hundred to one hundred and fifty feet above the sea, increasing from south to north. These enclose depressions from twenty to one hundred feet deep, many of which contain ponds. They are also intersected from east to west by broad valleys with steep sides, which have their bottom nearly at sea-level or below it. Examples of these are the hollow which extends from North Truro toward Highland Light, and that of Pamet river, which varies from a third of a mile to one mile in width, and cuts the cape quite across, its bottom, until recently dyked, being marsh overflowed by high tides.

The east side of the cape, through Wellfleet and Truro, is a nearly continuous bluff, one hundred to one hundred and sixty feet high, horizontally stratified, being evidently a remnant of a nearly level plain, the east part of which has been washed away by the sea. This process is still going forward, exposing fine sections of these deposits along most of this distance. The material is mainly sand and fine gravel, with coarse gravel in some portions, containing pebbles and fragments up to one foot or rarely two feet in diameter. Less than a half dozen larger blocks, none of them, however, so large as four feet through, were seen in this whole line of cliffs more than fifteen miles in extent. At the base of these bluffs banks of darkish sandy clay occur in several places, rising ten to forty feet above the shore and extending one hundred to five hundred feet in length. These beds enclose occasional pebbles up to one foot in diameter. At the Clay Pounds, close north of Highland Light, is a massive bed of somewhat similar sandy clay, bluish-gray in color, forty to fifty feet thick, extending a quarter of a mile to the west, as shown by wells, and the same distance along the cliffs to the north, where it gradually thins out. This deposit is finely laminated, level in stratification and free from pebbles. Its base is clearly seen in many places for an eighth of a mile holding a nearly constant height of forty feet above sea-level, and is marked by a hard fer-

ruginous layer one to three inches thick. It rests, by abrupt change, upon gravelly sand containing pebbles up to one inch through, and within ten feet below they occur up to six or eight inches in diameter. The thickest portion of the clay is at the south edge of a gully some thirty rods north of the lighthouse, where the section is gravelly sand to forty feet above the sea; clay fifty feet thick, and sand at top twenty-five feet. The upper part of the clay here and generally, is more sandy than its base, but it is still quite distinctly separated from the overlying sand. A quarter of a mile north the clay becomes narrower, and its base is higher, the section being sand and gravel to sixty-five feet above the sea, clay ten feet, and sand at top fifteen feet. Heights along this portion of the cape are as follows: in Eastham, fifty to seventy-five feet; Lombard's Head, in Wellfleet, about one hundred and twenty-five; highest portion of bluff in south part of Truro, one mile south of Pamet river, about one hundred and fifty; Small's hill, one mile north-east from Truro village, highest point beyond Barnstable on the cape, about one hundred and seventy-five; bluff one mile south of Highland Light, one hundred and sixty; base and focal plane of this lighthouse, one hundred and thirty and one hundred and eighty-five; High Head, about seventy-five.

As in Plymouth county the accumulation of these thick and extensive beds of modified drift, remote from any large river and here bordered on each side by the sea, seems capable of explanation only by supposing the material to have been held in the ice-sheet and deposited by the floods produced at its retreat. When the return of a warmer climate drove back the front of these ice-fields from their terminal moraine upon Cape Cod, the rivers which flowed down from their melting surface were discharged upon these areas, those at the south-west converging upon Plymouth county, while those which descended from the glacial sheet over the west part of the Gulf of Maine had their mouth in Wellfleet and Truro.

The only fossils that have been found on Cape Cod occur in the bluffs on the east shore of Truro, as follows: One mile south from the head of Pamet river the section shows gray sandy clay at base to about thirty feet above the sea; ferruginous gravel, containing broken and worn shells, and with its largest pebbles four inches through, five feet; overlain by more than one hun-

dred feet of sand with occasional gravelly layers. Four to eight rods farther south the clay rises ten feet higher, but at four hundred feet south and at one hundred feet north its top is only twenty feet above the sea. The bed of shelly gravel thins out at three or four rods on each side. Species found here are a *Balanus*, *Neptunea pygmæa* Adams, *Tritia trivittata* Adams, *Lunatia heros* Adams, *Turritella erosa* Couthouy, a *Mya* hinge, *Ceronia deaurata* Gould, *Mactra solidissima* Chem., *Cardium islandicum* L., *Cyclocardia borealis* Conrad, *Astarte undata* Gould, and *Pecten islandicus* Chem. A peaty or lignitic layer, about a half inch thick and extending five feet, was noticed at one place in white sand, three inches above this shelly gravel. A third of a mile north from the head of Pamet river, the bank is about one hundred and twenty-five feet high, consisting of sand with occasional thin layers of gravel, and containing fragments of shells to a height at least sixty feet above the sea. Among these *Ceronia deaurata* and *Pecten islandicus* were recognized. About a mile and a half farther north, or one mile south from Highland Light, the bluffs reach their greatest height, and here worn shell fragments were again found at two localities, a third of a mile apart, occurring in gravelly sand from near sea-level to at least one hundred feet above it. These include *Balanus* species, *Neptunea pygmæa*, *Aporrhais occidentalis* Sowerby, *Acmæa testudinalis* Forbes and Hanley, *Ceronia deaurata*, *Cardium islandicum*, *Cyclocardia borealis*, *Astarte undata* and *A. castanea* Say, *Pecten islandicus* and an *Anomia*. Lignite was observed at the most northern of these localities thirty to forty feet above the sea, in several layers an inch or less in thickness and at least four or five feet in extent. At about the same height the sand and fine gravel here contains clay boulders[1] or pieces of dark sandy clay of irregular shape, and varying in size from three or four inches to two feet long. These are changed to a brown color for a depth of a half inch from the outside, due to oxidation of their iron.

We have already seen that the unstratified character of portions of the terminal moraines, and the channels upon the plains that lie south of them, indicate that in this latitude, during the period when these beds were deposited, the sea stood somewhat

[1] Also found in the modified drift of Long Island, as described by Mr. Elias Lewis, Jr., in *Popular Science Monthly*, Vol. II, p. 634, and in North-western Ohio, according to Prof. N. H. Winchell, *ibid*, Vol. III, p. 202.

lower than now. The occurrence of these recent marine shells up to one hundred feet above the sea, would disprove this conclusion if they lay in an undisturbed condition so as to show that they lived where they now are found; instead of this, they are always more or less broken and worn, no two corresponding valves being found together; and their origin, as well as that of the lignite, clay boulders, and the much older fossiliferous pebbles, next to be described, seems to have been from pre-glacial beds which were formed on the floor of Massachusetts bay. These appear to have been eroded by the ice-sheet, lifted into its mass, and at its melting deposited anew by the glacial rivers, their marine shells being thus embedded in modified drift which was accumulated above the sea-level.[1] The species are of northern range, such as would have been found living in the ocean when it was invaded by the onflowing ice.

A third of a mile north from the last locality, and one half mile south from Highland Light, the bluff rises to a height of one hundred and fifty feet, and consists of sand and gravel, much coarser than usual, having pebbles of all sizes up to one foot in diameter, mostly rounded by water wearing, but a part of them angular, especially the larger pieces, some of which may be two feet long. The foot of the cliffs here is guarded from the waves by several rods of sea-sand covered by beach grass, so that the gravel and sand have fallen down in a steep slope strown with pebbles. Among these are occasional fragments of a whitish calcareous sandstone, thickly filled with shells, which were brought to my notice by Mr. David F. Loring, keeper of the Highland Light. They occur rarely for twenty or thirty rods along the face of the cliff at all heights up to one hundred and twenty-five feet, being most abundant between seventy-five and one hundred feet above the sea. Like the other pebbles, most of these pieces are more or less water worn, some of them being rounded on all sides, indicating that their mode of transportation and deposition were the same; but the stratification is obscured by falling down, so that we do not here find these fossiliferous pebbles actually embedded in the drift. Before seeing any of these specimens,

[1] Marine shells occurring in the till of Scotland are similarly attributed by Croll, Geikie and others, to erosion by the ice-sheet of previously existing marine beds and their transportation to higher levels, so that they cannot be accepted as proof that the sea stood at the height where they are now found. Geikie's "Great Ice Age," 2d edition, pp. 179–181.

however, I had found a fragment of the same shelly rock in the fossiliferous layer of gravel first described, one mile south from the head of Pamet river; and subsequently I found two other bits of it at the most northern locality of shelly gravel and sand last mentioned. These pieces were enclosed in stratified beds, in each case some thirty feet above the sea, evidently occupying their original position in the thick deposits of modified drift which form this part of Cape Cod. The fossiliferous pebbles are thus shown to have been brought to their present place by the same agencies which accumulated these beds of gravel and sand. As no similar formation is known on the land to the north from which they could be derived, it seems quite certain that they represent beds that were in place at the bottom of Massachusetts bay, whence they were ploughed up by the ice-sheet and carried forward and upward in it, till at its final melting they were deposited here.

The scarcity of these fragments is such, that a search of six or seven hours was required, where the whole bank, one hundred and fifty feet high, was plentifully strown with pebbles, to find a dozen of them. These, to the amount in all of perhaps twenty pounds' weight, were presented to the Boston Society of Natural History, and their fossils have been examined by Mr. W. O. Crosby,[1] who regards them as satisfactory proof that the rock is Eocene Tertiary. The species which he has identified are *Camptonectes calvatus* Conrad, found in the Middle Eocene of South Carolina; *Venericardia planicostata* Lamarck, found in the Lower Eocene of Virginia; probably *V. parva* Lea, found in the Eocene of Alabama; and another similar to the common *V. alticostata* Conrad, occurring with the last; probably *Ostrea divaricata* Lea, of Middle Eocene in Alabama, though perhaps young of *O. sellæformis* Conrad, a characteristic species of the Lower Eocene from that State to Virginia; another, principally in fragments, is similar to the recent *O. virginiana* Lister; another species of this genus is represented by fragments of shell fully one and a half inches thick, not enclosed in the matrix of calacreous sandstone like the rest, but found with these shelly pebbles on the cliff a half mile south of the lighthouse, and also in the shelly gravel south of Pamet river; an *Anomia* similar to *A. tellinoides* Morton, of the Cretaceous in New Jersey, Alabama

[1] Proceedings of Boston Society of Natural History, Vol. xx.

and Mississippi; a *Plicatula* similar to *P. filamentosa* Conrad, and an *Axinea*, closely like *A. staminea* Conrad, both of the Alabama Eocene; also probably *Striarca centenaria* Conrad, found in the Miocene of the Southern States. Other molluscan genera that were recognized are *Corbula*, *Cardium*, two species of *Yoldia* or *Nuculana*, several small *Turritella*-like species, and a small *Natica*. Echinoderms are represented by spines of a *Cidaris*, and cœlenterates by a simple cylindrical *Galaxea*-like coral.

In this connection it is interesting to notice that fragments of fossiliferous rock,[1] apparently of Miocene age, are brought up from the sea-bottom on George's Bank, Banquereau and the Grand Bank, by the coralline growths attached to them becoming entangled with fishermen's lines. These, with the Eocene pebbles of Cape Cod, show that the coast of New England, Nova Scotia and Newfoundland, one thousand miles in extent, is bordered by submerged Tertiary formations similar to those which occur above sea-level in the Southern States, as had been already suggested by Prof. C. H. Hitchcock[2] before these discoveries. It was a theory of Agassiz that the fishing banks, from which these Tertiary rocks are drawn up, represent the terminal deposits of drift accumulated at the front of the ice sheet. Both this and the theory of Prof. Hitchcock appear to be true, for besides the fossiliferous fragments many of granites and schists are also obtained by the fishermen. Furthermore the course of the extreme terminal moraine that crosses New Jersey, Long Island, Block Island, Martha's Vineyard and Nantucket has its line of continuation in these remarkable submarine banks, which probably consist, somewhat like Gay Head, of Tertiary strata covered with their own and foreign detritus brought by the ice-sheet.

The moraine of Cape Cod, the Elizabeth islands, Southern Rhode Island and the north shore of Long Island, was formed after the ice had retreated from its farthest limit, but while it still terminated eastward beyond the present coast line. This halt in its departure was extended along the entire margin of these ice-fields to the west, for a distance of more than two thousand miles. Although in the interior of the United States the extreme limit of glacial action has not yet been found to be generally marked by extraordinary deposits, a most notable series of terminal mo-

[1] Described by Prof. Verrill in *American Journal of Science and Arts*, 3d series, Vol. XVI, p. 323.

[2] *Appalachia*, Vol. I, p. 13, and Geology of New Hampshire, Vol. II, p. 21.

raines north of this line and probably contemporaneous with that of Cape Cod is found, as recently shown by Prof. Chamberlin,[1] stretching across Ohio, and represented in Southern Michigan, in the Kettle moraine of Wisconsin, and the Leaf hills of Minnesota; while its farther continuation seems to be in the Coteau des Prairies and the Coteau de Missouri of Dakota and British America, reaching north-westward, according to Mr. G. M. Dawson,[2] to the North Saskatchewan river, three hundred and fifty miles west of Winnipeg lake. These deposits, like the moraines of Southern New England, are made up entirely of drift materials, partly unstratified, with abundant boulders, and partly stratified gravel and sand, in hills one hundred to three hundred feet high, of very irregular contour, with many enclosed hollows and occupying a width of from one to thirty miles. They lie upon the uneven surface of the rocky strata, being continuous across valleys and ranges of highland, which in Wisconsin undulate eight hundred feet in vertical height, while the elevation of this entire series varies from sea-level at Cape Cod, to two thousand feet above it at the north line of Dakota. In the Western States the front of the ice-sheet is shown by Prof. Chamberlin to have been lobed, producing acute angles in its terminal moraine, with medial moraines extending northward from them; corresponding to which we find a deflection of ninety degrees in this series of hills on Cape Cod at North Sandwich with the massive medial range of Pine and Manomet hills a few miles farther north, in Plymouth. The same lobed character appears also to have marked the ice-sheet at its greatest extent, leaving a large driftless area in Wisconsin, and making angles similar to those of a later period in its frontal line, as indicated by the drift-hills of Martha's Vineyard and Nantucket.

The north end of the modified drift of Cape Cod is at High Head; and the whole of Provincetown, at the extremity of the peninsula, consists of sea sand with no pebbles. This sand has come from the erosion by the sea of the east shore of the cape; has been swept north and west by tidal currents to its present place in the lee of this breakwater; lifted by the waves into beach-ridges and further raised by the wind into hills a hundred feet in

[1] "On the Extent and Significance of the Wisconsin Kettle Moraine," in Transactions of Wisconsin Academy of Science, 1878, with maps.

[2] In *Quarterly Journal of Geological Society*, Vol. XXXI, pp. 614–623, with map.

height. From Nausett Lights to High Head much of the cape, as it originally was, has been demolished, and the process is still going forward; but the sea restores a part of what it takes, forming this curved bank of sand, five miles long and one to three miles wide, which encloses the deep and commodious harbor of Provincetown. The section here, to a depth of one hundred and eighty-two feet, was shown by a boring made some twenty years ago at the end of Central wharf. Sand extended from low tide line for thirty-five feet, below which interstratified sand and fine gravel continued to one hundred and seventy feet, where the first clay was encountered. This was dark-colored and very compact, extending twelve feet, at which depth it was not penetrated. Shells of *Scapharca transversa*, *Ostrea virginiana* (at one hundred and twenty feet), *Lunatia heros* and others were found to the depth of at least one hundred and forty feet. Successive generations of these inhabitants of the sea have been buried during this accumulation of its detritus, and at the same time its waters have probably been gradually rising upon the land.

The height of the principal hills of this town, as determined by Major Graham of the Coast Survey, are as follows: Mt. Ararat, one hundred feet above mean low tide; Mt. Gilboa, one hundred and six; Oak Head, one hundred and four; Miller's hill, eighty-nine; High Pole hill, one hundred; Telegraph hill, ninety-eight; Creek hill, eighty-four. These are dunes on the harbor side which have mostly become covered with bushes and trees. Others of nearly equal height, occupying the side next to the ocean, are drifted by every passing wind, allowing no foothold to vegetation; and clouds of sand, seen at the Highland Light, are lifted from this tract by gales to the height of three or four hundred feet.

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THE HILLOCKS OR MOUND-FORMATIONS OF SAN DIEGO, CALIFORNIA.[1]

BY G. W. BARNES, M.D.

THE surface geology of many sections of the Pacific slope is characterized by innumerable hillocks or small mound-like formations, either sparsely distributed or occupying quite densely areas of considerable extent. These formations, variable in size

[1] Read before the San Diego Society of Natural History, April 5, 1879.

and structure in accordance with local conditions concerned in their production, exist in many parts of California and on the coast north of it, and are especially abundant and well defined in Southern California.

The following conclusions are based upon observations of them chiefly in the vicinity of San Diego:

In their most common type the mounds may be described as rounded eminences, or knolls, rising from one to four feet above the surrounding surface or the depressions between them, and ranging from ten to fifty feet in diameter. They are generally nearly circular and distinct, but are, in some instances, confluent or elongated. They are separated by wide and irregular areas or by narrow intervening depressions, the latter containing, in stony places, accumulations of cobblestones. They are confined to no geological structure or quality of soil, and are found on sloping lands, on the higher mesas and lower levels.

Any attempt at an explanation of their origin and the mode of their formation must be based upon the assumption that they are modern modifications of the earth's surface and are due to natural agencies; and evidences abound on every hand that the causes concerned in their production are still active in the formation of new and in the maintenance of the old ones; and hence in this vicinity they may be seen in all the stages of their growth, from small rudimentary cones to the fully developed knolls.

Several agencies acting successively or simultaneously have been concerned in these formations. Each mound marks a spot where formerly grew a shrub or cluster of shrubbery, which served to fix its location and which exercised an important influence in the successive stages of its development. The shrubs which seem to have been chiefly instrumental in these results are the *Rhus laurina*, the *Simmondsia californica* and the *Isomeris arborea*; the former undoubtedly having been principally instrumental in the creation of the more recent as well, perhaps, as the most ancient ones in this vicinity. These plants are fitted for the office they perform by the nature of their growth, which is in compact groups or clusters, with many stems starting from the earth near together, the branches and foliage forming a dense mass resting closely upon the ground, and with beds of massive roots; while the distribution of the groups is strikingly similar to that of the mounds in their typical form and arrangement.

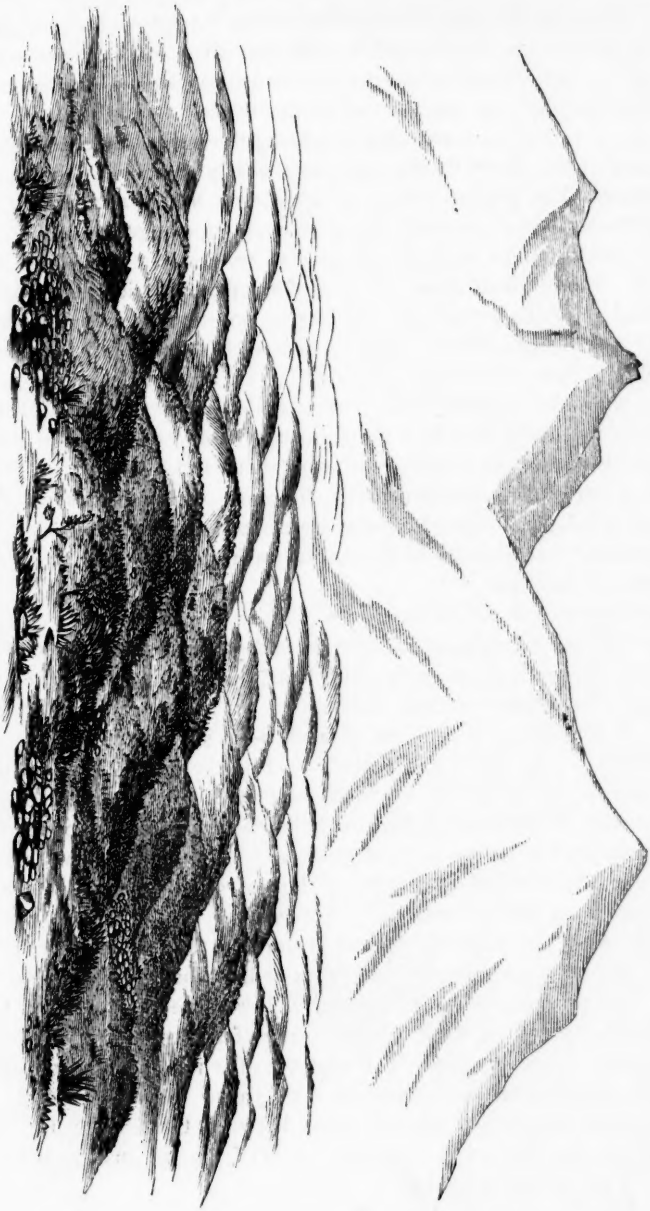

FIG. 1.—Hillocks seen in outline near San Diego, Cal.

Dust set in motion and borne along by the winds is arrested by the shrub and, together with its fallen leaves, accumulate within and around it, and, as is seen in thousands of instances in this vicinity, an elevation of many inches is produced in this manner alone, in many cases covering the lower branches, and in case of the Simmondsia especially, nearly enveloping the whole plant. The gopher, subsisting upon roots and preferring for its operations the loose soil about them, is, in exceptional cases, an adjunct of the wind in heaping up material about the plant. Of the thousands of these clusters of shrubbery which have come under my observation, a very large proportion show unquestionable evidences of these agencies in elevations more or less marked about them, the surface portions of them at least being generally composed of a light loam of dust and decaying leaves. While the loose earth of which the deposit is composed is protected by the branches and foliage of the plant, the more solid earth beneath is also protected from the wash of rain by its massive roots, while all around erosion goes slowly on, facilitated by the peculiar susceptibility of the soil to wash, a quality familiar to the casual observer.

Instances doubtless exist in which the mounds have been more or less fully developed without the aid of those forces which elevate the earth above its original level, but the shrub and the rain wash have been constant factors.

In the course of time the plant dies—is smothered by the drift which nearly covers it, or is destroyed by the fires which annually sweep over extensive tracts of country. Thus deprived of its protection, the winds in turn, and the rains which fall upon it wear down the top of the loose deposit, and to some extent widen its base. While this is going on the surrounding earth, or interspaces, are being continually lowered by the action of water. The wash always being greater at the base than at its summit, its tendency is to perpetually maintain or increase the prominences.

The presence of beds of roots, well preserved as well as in the different stages of decay, within many of the more modern fully formed structures, upon the surfaces of which it is known from observation that no vegetation has grown for many years, is strongly suggestive of a relation between them of cause and effect. In the oldest ones all traces of the original roots have long since disappeared.

A well known effect of timber and shrubbery everywhere is to

impede the drainage of water which falls among it, and so these groups of plants serve to diffuse the currents—which would otherwise be concentrated into gulleys—whose meanderings may be traced in all directions among the mounds, thus conducing to the symmetry of their form and arrangement.

The influence of wash in these results is the most marked on moderate slopes, though sometimes seen on quite steep ones and on comparatively level places, but if upon levels, the latter are so situated as to receive the gathered waters from neighboring slopes. In a situation of this character near at hand the water, after traversing a surface of considerable extent among fully developed mounds, converges into a gully and a surplus flows off to the sea.

Evidences of the potent agency of the winds in results of greater magnitude than these need not be adduced. We need only refer to the sand dunes of Scotland and the shores of the American lakes. It is a matter of common observation here that during the prevalence of one of the "sand storms" of a few hours duration, which visits us once or twice annually, several inches of dust is deposited in places suited for its lodgment, yet the work here ascribed to the wind is mainly carried on by prevailing breezes from the ocean. In situations exposed to concen-

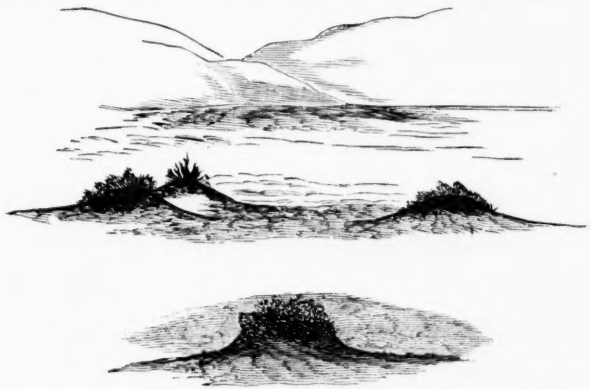

FIG. 2.—Simmondsia with earth heaped about them as in first stage of formation. From nature.

trated wind currents or their sweep over loose earth or traveled roads, the cones are the most sharply defined, showing that in such circumstances the work goes more rapidly on.

As a minor and exceptional agency I may mention that in the

later stages of the formations large excavations are sometimes made by the burrowing of animals, which are afterwards filled with débris, while the matter thus brought to the surface remains to augment the elevation. Hills formed in open spaces by animals do not constitute nuclei for mound-formation; composed as they are of a substratum in which no grass or other vegetable takes root and protects them from dissolution, they crumble away leaving but a bare and level spot.

To recapitulate; in the incipiency of the formation the elevation is composed entirely of a deposit heaped often abruptly about the plant (Fig. 2, Fig. 3 *a*), but pretty soon the influence of erosion is manifest in the subsidence of the base.

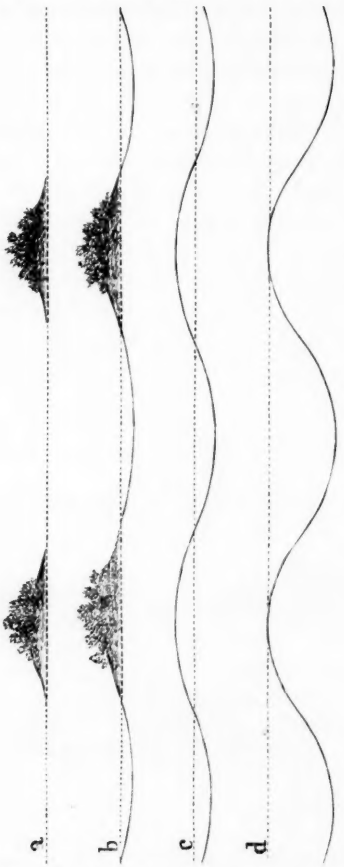

FIG. 3.—Ideal profiles of successive stages of the formations. The dotted lines represent the original surface of the earth.

Next the plant perishes, and, deprived of its protection, the summit is reduced and the base widened as it is lowered (Fig. 3 *b*) till finally a remnant of the deposit has become so assimilated and compact as to constitute a more permanent summit (Fig. 3 *c*), or it has totally disappeared, leaving the summit at or below its original base (Fig. 3 *d*).

Reasons for the appearance of these phenomena so exclusively on the Pacific slope and the arid plains of the West, are that the combination of causes resulting in their production there are seldom found elsewhere, to wit: the growth of shrubbery in compact clusters suitably distributed, with low and dense foliage, the presence of burrowing animals, the great susceptibility of the soil to wash and, I may add, the steady prevalence of winds from a single quarter, and the absence of forests which would otherwise influence winds and surface drainage.

Note.—Since the foregoing was written it has been suggested to me by a gentleman whose opinions have much weight, that the wind exercises an influence in excavating the earth around and between the shrubs of which the mounds are a sequence. While there is no evidence of such action in this vicinity, the explanation doubtless holds good in sections of the country in which a loose or sandy soil prevails. The mounds of this vicinity are found almost exclusively on the upland which, when dry, is quite firm and is not perceptibly acted on by the wind, yet sweeping over a considerable surface it gathers enough of soil, in time, to make large deposits about the shrubbery. Sandy soil is exceptional, and is found usually only in the valleys which are comparatively small in extent. In such situations the suitable vegetation does not so commonly exist, there is more protection from the winds, and the rains, generally light, are so readily absorbed that no surface-wash takes place.

It has also been suggested that pebbles and rocks form nuclei around which accumulations of soil remain and conduce to the production of the hillocks. It must be conceded that this is possible, and in certain qualities of soil and with certain kinds of rock quite probable. In this vicinity, however, in no stage of the process are the stones imbedded in the mounds found to be bare, or protruding, or to hinder in any manner the action of water on the soil; on the contrary, in a soil so easily disintegrated by water, the stones hold their positions by an uncertain tenure, and are so readily rolled from their cavities, as the earth is washed away from them, as to rather facilitate than retard the process of erosion.

INSECT POWDER.

BY WILLIAM SAUNDERS.

THE insect powders of commerce are the powdered flowers of different species of Pyrethrum. Those of *Pyrethrum carneum* and *roseum* were introduced some thirty years ago under the name of Persian Insect Powder, and subsequently those of *Pyrethrum cinerariæ folium*, a native of Dalmatia, Austria, as Dalmatian Insect Powder. Both the Persian and Dalmatian powders are good insecticides, but the latter is much the more energetic in its action and hence commands a higher price; indeed, it is so much preferred that it is gradually driving the so-called Persian powder out of the market. The fact of the flowers of *P. roseum* being less active than those of *P. cinerariæ folium*, has been accounted for on the ground that the single flowers are much more powerful than the double ones, and that the double flowers occur in *P. roseum* in much larger proportion than in the other species. The flowers, either whole or powdered, preserve their activity for a long period. A recent European experimenter states that he could not perceive any particular loss of activity in samples which had been kept six years. The fresh (undried) flowers act very slowly as compared with the same dried and powdered, and the plant itself powdered is quite inactive. It is singular that while there are many other composite plants closely related to the genus Pyrethrum, as yet this peculiar property has been found only in plants belonging to this genus, and even within this limit there are several species whose value as insecticides is very slight. A large number of Compositæ indigenous to Austria have been tested and found to be of no value in this respect. The flowers of Tansy (*Tanacetum vulgare*) are said to have a slight stupefying effect.

The Pyrethrums are hardy plants which bloom abundantly the second year from seed. The powder is prepared from the half-opened flowers gathered during dry weather and dried in the shade under cover, but the process of gathering, drying and preparing involves so much time that their culture can only be made profitable where labor is cheap.

Insect powders have not attracted general attention as insecticides until within the last three or four years, during which time they have been introduced in various forms in packages and

boxes, accompanied by suitable blowers or insect guns for the purpose of properly distributing the powder, and recommended for the destruction of flies, cockroaches, fleas, bugs, &c. Sometimes these prepared articles have been artificially colored so as to disguise their source, but all have owed their activity solely to the presence of the powdered flowers of one or other of these Pyrethrums.

House flies are very sensitive to the effects of these powders. A few puffs of the dust from an insect gun, blown into the air of a room with the doors closed, the discharges directed towards those parts where flies are congregated, will stupify and kill them within a very short time. The powder is somewhat pungent, and to breathe an atmosphere charged with it will frequently cause a slight sneezing, but beyond this the operator need not anticipate any annoyance. Frequently during the past summer, when flies have been troublesome, we have pretty thoroughly charged the air in our dining-room and kitchen at night, closing the doors, and in the morning found all, or nearly all, the flies lying dead on the floors. A few minutes after its use they begin to drop on their backs, and after a very short time die; if a room be closed for half an hour after using the powder, few, if any, will escape. By some this energetic action has been attributed to the presence of a volatile oil in the flowers, by other and later investigators to a peculiar crystalline principle believed to be an alkaloid; but this point does not as yet seem to be fully settled.

More recently we have been experimenting with this powder on the green Aphis which troubles our green-house plants. The usual plan of smoking with tobacco is an unpleasant remedy, and is also very injurious to many plants of delicate constitution, whereas the insect powder, used to any extent, is perfectly harmless to plant-life. After freely charging the air of a green-house with the powder, blowing it in fine clouds of dust among the plants, the tiny tormentors who are busily engaged in sucking the life out of the leaves and tender shoots, soon manifest symptoms of uneasiness and begin to drop from the plants to the ground, and in the course of an hour or two the larger portion of the enemy's forces will be found lying sprawling on the earth in the pots or on the shelves and floor of the house, where, probably partly from the stupefying effects of the powder and partly from their natural inability to find their way to any given point, they fail to

reach the plants again and hence perish. By applying the powder freely in the evening and giving the plants a thorough syringing in the morning, they may in the worst cases be almost freed from Aphides by a single application; it is better, however, to repeat its use the next evening, so as to make sure work. The powder does not appear to kill this Aphis as it does the flies. For the purpose of testing this point we placed a number of them in an open glass cell of a microscope slide and powdered them thoroughly, and found some of them alive after two days of such severe exposure to its influence. Having recently found a plant literally swarming with the green Aphis, so that the sight of it was almost disgusting, we submitted it to the action of this powder one afternoon, having previously spread a large piece of white paper under the plant, so that the effect of the powder on the insects might be distinctly seen. Almost immediately they began to fall on the paper, and in less than ten minutes a hundred or more of them were lying on their backs or crawling sluggishly about. In the course of half an hour some four or five hundred had fallen on the paper, and when the plant was examined again the following morning, there remained but very few on it, and most of these were removed by a slight syringing. We have had the powder used in green-houses by some of our friends, who also report its success. This matter is well worthy the attention of all those who indulge in window gardening or who grow plants in small conservatories attached to dwellings, since if this proves an efficient and economical substitute for tobacco smoke, it will save much annoyance and some loss. Success will necesarily depend on the quality of the material used, but after the experiments we have tried, we feel confident that with good Dalmatian powder there need be no failure. It will be interesting to learn, as opportunity offers, how moths and other insects will be affected by the use of insect powders. If the beautiful specimens which sometimes fly into our rooms at night can be drugged in this way and captured without a struggle, we may add many a perfect specimen to our collections which would otherwise be more or less defaced. There is quite a field for experiment here.—*Canadian Entomologist.*

RECENT LITERATURE.

MIERS' CRUSTACEA OF COREA AND JAPAN.[1]—In this paper are enumerated sixty-four species of Decapods, of which twenty-six are new. Five new genera, *Pleistacantha*, *Pseudophilyra*, *Paratymolus*, *Pornatocheles* and *Heterocuma* are indicated. *Portunus strigilis* Stm., is shown to be *P. corrugatus* Leach, which was well known from the shores of Europe and the Miditerranean. *P. subcorrugatus* A. M. Edw., from the Red sea, is regarded as but a variety of this species, and specimens are reported from Naples. *Paracrangon echinatus*, which previously was only known from Puget sound, is reported from Yedo island. Before beginning the descriptive portion of his article, Mr. Miers has a paragraph on the geographical distribution of the species, in which he notices the affinity between the Japanese Crustacea and those found in the Mediterranean, a similarity which was commented upon by Dana in his chapter on the Geographical Distribution of the Crustacea, in the volumes of the U. S. Exploring Expedition. A similar resemblance is also pointed out between the west coast of North America and Japan. It would seem, however, to the writer, that the true Japanese fauna, as well as that of China, is the most closely allied to that of the Southern United States, and that the resemblances of Japan to Western North America is by means of northern genera, as is that of New England to the coast of Europe. A similar resemblance in the land plants has been pointed out by Prof. Gray in the pages of the NATURALIST. Briefly, our reasons for this opinion are as follows: Crustacea have been described from the coasts of China and Japan belonging to one hundred and sixty-seven genera, one hundred and thirty-six being found in Japan. Now, throwing out all genera which are found only on the eastern coast of the Eastern Continent and the Pacific isles, and also all which are found on both coasts, and we have left forty-six genera with which to show the affinities of the Japanese fauna. In the following table these genera are given with a rough approximation as to their geographical distribution. The writer is fully aware that deficiencies will be found in it, some owing to the lack of literature and others to the fact that the generic limits vary greatly as used by different authors. Old genera have been dismembered and new ones created, and it is not always easy to assign the species described by the older authors to their proper position. This course of genus making and genus splitting has been severely criticised, but one can easily see how in a study of the geographical distribution it aids in showing analogous forms on the various coasts.

[1] *On a Collection of Crustacea made in the Corean and Japanese Seas.* By EDWARD J. MIERS. (Proceedings of the Zoölogical Society of London, 1879, pp. 18–61, pls. I–III.)

GENERA.	Japan.	China.	Puget Sound.	California.	Panama.	W. Indies & Gulf of Mexico.	South-eastern United States.	Europe.	Mediterranean.	West Coast Africa.	East Coast Africa.	Indo-Pacific Ocean.	Pacific Isles.	Australia.	Brazil.	West Coast South America.	Cape of Good Hope.
Achæus	o							o	o					o			
Oregonia	o		o														
Chorilia	o		o	o													
Schizophrys[1]	o	o							o		o						
Scyra	o		o				o										
Platylambrus	o					o	o					o					
Cryptopodia		o		o		o	o										
Xanthodes	o				o					o							
Ozius	o	o			o	o							o	o			
Achelous	?					o	o			[2]	o	o	o		o	?	
Goniosoma	o	o									o	o	o	o			
Portunus	o						o	o	o	o							
Trichocarcinus	o		o														
Telmessus	o		o														
Heterograpsus	o	o	o	o					o								
Helice	o	o												o			
Pinnixa	o			o			o					o	o				
Thelphusa	o								o	o		o	o				
Philyra	o									o		o					
Ebalia	o						[3]	o	o	o							
Ethusa	o								o								
Dromia	o	o				o											
Latreillia	o								o								
Pachycheles	o			o		o									o	o	o
Polyonyx		o					o										
Cryptolithodes	o		o	o													
Hapalogaster	o		o	o													
Diogenes	o	o						o	o					o			o
Aniculus	o				o								o	o			
Spiropagurus	o					o											
Cœnobita		o			o	o		o	o			o	o				
Galathea[4]	o	o						o	o				o	o			o
Munida	o							o	o								
Scyllarus	o					o		o	o	o		o	o				
Ibacus		o				o						o		o			
Panulirus	o	o		o	o	o	o				o	o					
Astacus		o		o				o									
Paracrangon	o		o														
Hippolysmata		o		o		o	o										
Tozeuma		o					o										
Latreutes	o						o										
Rhynchocyclus[6]	o	o				o								o			
Ogyris	o	o					[7]										
Urocaris	o						o										
Solenocera	o								o								
Totals	38	18	9	9	5	12	14	8	13	7	4	10	9	7	3	1	3

[1] *Schizophrys dichotomus* Stm. (*Mithrax dichotomus* Desm.) is reported by Adams & White in the Crustacea of the Voyage of the *Samarang* from the Philippine islands; it is a well known Mediterranean form. [2] *G. mulleri* A. Medw., from the Cape Verdes. [3] Desbonne and Schramm report two species from Gaudaloupe but their generic position is doubtful. [4] *G. monodon* Edw., from Chili, belongs to the genus *Pleuroncodes* Stm. [5] *Angasia pavonia* Spence Bate, Proc. Zool. Soc., London, 1863, p. 498, pl. xi f. 1, from Australia, appears to belong to the genus *Tozeuma*. [6] *Caradina truncifrons* Sp. Bate, l. c. p. 499, pl. xi f. 2, from Australia, appears to be near this genus. [7] *O. alphæ-rostris* n. sp. from Virginia.

From this table it will be seen that of the forty-five genera noticed, ten are common to the east coast of the Eastern continent and the east coast of America only, four additional have the same distribution, including Australia and the Pacific isles, three are found on both coasts of the Eastern continent and on the eastern coast of America, seven exist only on the shores of the Pacific, eleven belong to the Eastern continent and the Pacific isles alone, four are found on both shores of America but not on the coasts of Europe or the western coast of Africa, three are found on the Pacific coast of America and in Europe, and three on the east coast of America and in Europe but not on the west coast of America. To sum up: of these forty-five genera seventeen are found on the Pacific coast of America, twenty-five on the eastern side, seventeen on the western coast of the Eastern continent and in the Mediterranean. The cases of the Pacific genera which are common to both coasts, e.g., *Oregonia, Telmessus, Haplogaster*, &c., are in several cases to be explained by the fact that they are boreal genera, and analogous cases will at once suggest themselves in regard to the fauna of the coasts of the North Atlantic. The cases of *Liomera luta*, which has been reported from China, the Pacific islands and C. St. Lucas, *Cœnobita rugosa* from the Indian ocean, Australia, the Pacific, and of which there are specimens in the Museum of the Peabody Academy of Science from Panama, and of *Platyonichus bipustulatus* from New Zealand, Japan, India and Chili, are paralleled by similar facts in the distribution of *Leptopodia siggitaria, Litinia dubia, Xantho vermiculatus*, &c., which are found on the eastern shores of the Atlantic. Another fact to be noticed in comparing the fauna of Japan and the eastern seas with that of the Atlantic coasts of America is, that certain genera which are peculiar to one region are represented in the other by allied forms, for example, *Leptopisa, Panopeus* and *Eucratopsis* of the American waters are represented on the Asiatic coasts by *Tiarinia, Heteropanope* and *Eucrati*.

An examination of Gunther's Fishes shows a similar identity in the genera of the eastern coasts of the two continents, but in Edmund Perrier's article on the Geographical Distribution of the Asteridæ no such similarity can be noted. It is my desire to carry out the investigation of this resemblance further, and any facts or references bearing on the geographical distribution of marine forms will be very acceptable, and due credit will be given therefor.—*J. S. Kingsley, Norwich, N. Y.*

Bronn's Classes and Orders of the Animal Kingdom.[1]—This famous series of six volumes is now drawing to a close, the

[1] *Dr. H. G. Bronn's Klassen und Ordnungen des Thier-Reichs, wissenschaftlich dargestellt in Wort und Bild.* Fortgesetz von Dr. A. Gerstæcker. Fünfter Band. Gliederfüssler. Arthropoda Lieferung 1–27. Leipzig und Heidelberg, 1879. 8vo, with many lithographic plates.

volumes on birds and Crustacea being apparently nearly completed, the Molluscs and Radiates having been published several years ago. The work is a compilation from numerous memoirs and papers, being encyclopædic in its nature, and the most authoritative, complete general account of the different classes and orders of the animal kingdom to be found. The plates are filled with figures, chiefly anatomical and developmental, from the memoirs and works of the leading authors, and are, in general, excellent copies. The present work on Crustacea is done in Dr. Gerstæcker's best style. The last part is taken up with the Trilobites, which are treated of with great thoroughness and copiousness of illustration. Though a somewhat expensive work, it is invaluable as a work of reference, and we call attention to it because of its great usefulness to any one living out of reach of extended libraries.

BAIRD'S ANNUAL RECORD OF SCIENCE AND INDUSTRY.[1]—This is one of a series of eight yearly volumes which fills a place in popular scientific literature not occupied, and will prove to be a very useful compendium of annual progress in science in Europe and this country. Reference to the index, which by the way is an admirable one, will show how many items are inserted in this well packed book, and just how fruitful the year 1878 was in scientific discoveries, whether of pure or applied science. The number who have assisted the editor are thirteen. This volume is of the same nature as the one issued for 1877, having a less number of pages than those from 1871 to 1876, owing to the omission of abstracts of scientific papers, for which it was impossible to find sufficient space. We have noticed the series in former years, and now recommend it as reliable, condensed, most useful and, in short, indispensable to teachers and editors as well as to the general reader.

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[1] *Annual Record of Science and Industry for 1878.* Edited by SPENCER F. BAIRD, with the assistance of eminent men of science. New York, Harper & Brothers, 1879. 12mo, pp. 715.

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GENERAL NOTES.

BOTANY.

ON THE FERTILIZATION OF SYMPLOCARPUS FŒTIDUS.—Belonging to the Aroidæ, and possessing at once an odor unpleasant to man, and a spathe of a brownish or reddish-purple color, the "skunk cabbage" would probably be taken at first sight as a good example of what Müller calls a loathsome flower—a flower which by its color and odor repels all insects save carrion-loving flies and beetles, and whose fertilization, if dependent upon insects at all, must depend upon those of this kind. From the partly closed spathe it might be further inferred that this is a good example of a plant in process of transition from the state of a completely open loathsome flower, like *Calla palustris*, to that of one in which the spathe has been so modified by natural selection as to be converted into what Müller would call a kettle trap, as is the case with *Arum maculatum*, the object of such a trap being to detain any insects which enter the spathe until they shall have performed the office of fertilization for which they were enticed into it. If a few of the largest spathes are secured in the first warm days of spring they will probably be found already in bloom, and a moment's inspection will show us that the flowers clustered on the stalked globose spadix are proterogynous; for while the delicate stigmas of some are protruded from the floral envelopes, their stamens are still enclosed and immature. It will also be found that the flowers which are open are those situated near the top of the spadix. These flowers, then, are ready to be fertilized, but pollen for their fertilization must be brought from another spadix. In the course of a week or two, for the rapidity of development depends in large part on the warmth of the season, the aspect of our spadix will have entirely changed, for the stigmas of the upper flowers will be withered and the stamens of these same flowers will now protrude from their envelopes and shed their pollen. Meantime the stigmas of the lower flowers have matured, and some can evidently be fertilized by the mere falling of pollen from the upper flowers without any extraneous aid, for pollen is shed in such quantities that it covers the bottom of the spathe.

On the first warm and sunny day we repair to a sheltered swampy place where we find our plant, and proceed to look for the little flies that we expect to find in the spathes, whither they should be attracted by the color and odor, and by the shelter offered; but no flies appear. While we are looking a hive-bee alights on a spathe and enters it. Approaching, we see her busily engaged in collecting pollen, meantime creeping back and forth over the surface of the spadix, which, as well as her body, is thoroughly covered with the yellow dust. Other observations show that each spathe is daily visited by scores of hive-bees,

some of which are unable to escape from the spathes and die there. A little later in the season a small bug (Hemipter) may be found in small numbers on the spadices, and they are usually well dusted with pollen. Occasionally a slug or the slimy trail of one is found within a spathe, and usually they pass over the spadix. A couple of weeks after finding the first bee the spathes will be found swarming with the minute black flies that were sought in vain earlier in the season, and their number is attested not only by the hundreds of them which can be seen, but also by the many small but very fat spiders whose webs bar the entrance to three-fourths of the spathes. During the present spring a few specimens of a small scavenger-beetle (*Ips fasciatus*) have been captured within the spathes of this plant. What they were after I can scarcely say, but they may have been visiting spathe after spathe in search of one with a decaying spadix, for the prolonged cold and wet weather caused many to decay, or they may have been in search of flower-food.

Considering these facts, it appears that with us hive-bees are not deterred by the odor of the flowers from visiting them and collecting their pollen, and that their visits are so frequent as to render them the chief agents in securing the cross-fertilization of the flowers, at least very early in the season. Later a few bugs and beetles may be of some use in transferring pollen, as also in a slight degree the spiders which take up their abode within or at the entrance of the spathes. Slugs and snails enter as agents for the transfer of pollen in a few cases, as might be expected from what Delpino has shown with regard to their habits in visiting plants related to this. Finally, other and more attractive flowers opening, the bees appear to cease visiting those of this species, and countless small flies take their place, compensating for their small size by their great numbers.—*William Trelease.*

Botanical News.—To the *Bulletin* of the Torrey Botanical Club, Mr. N. L. Britton contributes notes on the relative age and dimensions of a number of different trees. Dr. G. Engelmann farther notices the differences between *Vitis riparia* and *cordifolia*. The death of Dr. Rugel, in Tennessee, an excellent botanical collector, is announced.——Vol. vi, Botany of Lt. Wheeler's Report upon U. S. Geographical Surveys west of the 100th meridian, consists of "Reports upon the botanical collections made in portions of Nevada, Utah, California, Colorado, New Mexico and Arizona, during the years 1871–75," by Dr. J. T. Rothrock, who has been aided by Messrs. Engelmann, Porter, Watson, Bebb, Vasey, Boott, Eaton, James and Tuckerman. Fifty new species are described and mostly figured. The catalogue is preceded by chapters on the botany of the Colorado district, the New Mexican district, and on Economic Botany. Prof. Eaton's report on the Ferns of the South-west relates to all the ferns hitherto discovered in the regions of the United States lying

west of the 105th degree of west longitude, and south of the 40th parallel.——In the *Botanical Gazette* for July, Mary C. Reynolds notices at length certain Floridian ferns. E. T. Smith notices a new form of *Trillium grandiflorum* from Michigan. A writer over the initials C. R. B. calls attention to the neglected botany of West Virginia.——Fritz Müller questions, in *Nature*, whether many of the varieties of bananas have not been produced by bud-variation.——In the *Mittheilungen* of the Natural History Society of Bern, Herr Frankhauser contributes a paper on the most important conditions of shape in the leaf of phanerogamic plants, and a second one on the principal laws of growth in Florideæ, and Dr. Pertz notices some luminous bacteria.——In an important memoir on the ovule of plants, Prof. Warming discusses the early development of the leaf or "ovular mamelon," the genesis of the nucleus and the formation of the integuments of the mamelon. According to a reviewer in *Nature* he demonstrates that the theory of Brogniart as to the morphological significance of the ovule is the true and solely admissible one, and he reasons very conclusively against the views of Bronn, Eichler and Strasburger, who would regard the ovule as a bud, while in reality, as he says, "the ovule is the homologue of a sporangium."——Mr. L. Lesquereux contributes an article on Cordaites bearing fruit (with a plate) to the Proceedings of the American Philosophical Society.

ZOÖLOGY.[1]

DOES THE FOX SNAKE "MIMIC" THE RATTLESNAKE? — On May 24th a fact came under my observation which until then was unknown to me; it may, however, not be new to other readers of the NATURALIST.

While examining an exposure of lower magnesian limestone in the glen at the Junction mill, my attention was called to a large spotted snake lying upon the stump of a fallen tree, where it was stretched at full length basking in the sun over the stream. Before I could reach the spot the snake had apparently suspected danger and had retreated to a clump of grass near the foot of a tree where, by diligent search, it was at last discovered. Desiring to obtain the specimen alive, if possible, I placed my foot upon the body of the snake near the middle, when, to my surprise, there followed a buzzing sound that caused me to spring backward, thinking I had encountered a rattlesnake.

A blow from a stick disabled the snake but did not stop the buzzing sound, which was repeated several times, and the motion of the tail was distinctly observed by myself and my friend, Mr. F. F. Watson. The terminal inch and a half of the tail alone participated in the vibration, and was thrown rapidly from side to

[1]The departments of Ornithology and Mammalogy are conducted by Dr. ELLIOTT COUES, U. S. A.

side over an arc of about three-fourths of an inch, moving so rapidly as to appear like a dull fan-like glimmer. In every instance observed the tail was raised but little above the horizontal, and the buzzing sound was continuous through a few seconds only.

Is this to be called an example of "mimicry"? May it be said that far back in the past some sagacious ancestor witnessing that act of intimidation on the part of the rattlesnake, and observing how successful it was, resolved to adopt the practice itself; and thus, through inheritance, the practice became engrafted upon this species? If so, that ancestor, it would seem, must have possessed a keenness of perception, an accuracy of judgment and a depth of reasoning human-like in a high degree, and far above what is usually recognized among the members of its class.

If the fact under consideration is not an example of "mimicry," may it be said that some ancestor in one of its battles accidentally moved its tail from side to side so rapidly as to produce a strange buzzing sound that frightened its antagonist away; that that snake possessed the sagacity to connect the flight of its enemy and the buzzing sound with the rapid motions of its tail; and that by continued repetition of this feat in subsequent battles, there were wrought structural and mental changes sufficiently fixed to be inherited?

If all this be granted, and it is very unsatisfactory reasoning to me, we have possibly a clew to the beginning of differentiation in the tail of the rattlesnake.

There can be but little doubt but that the specimen under consideration is the fox snake, *Coluber vulpinus*, although I have at hand only the abbreviated description found in Jordan's "Manual of Vertebrate Animals."—*F. H. King, River Falls, Wis., May* 26, 1879.

Breeding of Land-locked Salmon.—Land-locked salmon, in the Schoodic waters (Maine) are occasionally found filled with ripe spawn in the spring. This seems a curious circumstance in fish which normally spawn in the autumn months, and perhaps may be considered a case of retarded development. In our own experience we have never seen melt in the male fish at this out-of-season, and it would seem as if it but needed the concurrence of retardation in the two sexes, and their coming together, in order to change the breeding habits of the species. What is curious, if a general fact, the instinct of propagation in these untimely fish seems inferior to that instinct which governs their habits of life. Normally, during the breeding season, these salmon seek the rapid streams, but these spring fish, filled with spawn, are found in the waters of the lake along with others of their species. In order to give directness to this statement we would state that, for one instance, on June 2d we took from the

lake a large healthy fish which extruded into the boat apparently healthy eggs as large as peas, and more were afterwards forced out in abundance by gentle pressure. In the young fry from last year's hatching, the yolk sac was scarcely absorbed at this time.—*E. Lewis Sturtevant, M. D., S. Framingham, Mass.*

NOTES ON AMERICAN CRUSTACEA.—Having recently been studying the Crustaceans belonging to Union College, kindly loaned me by Prof. H. E. Webster, I have thought best to place on record some of the more noticeable features of the collections. I hope, however, at an early day to publish a more extended notice. Enough specimens were found to show the identity of *Othonia anisodon* with *O. aculiata* (Gibbes) Stm. A new species of *Actæa* (*A. spinifera*) occurred from Plantation Key, Fla. This species closely resembles *A. hirsutissima* (Rüppell) Dana, from the Indian ocean and the Red sea, and differs from all other American species in the character of the antero-lateral teeth, which closely resembles those of *A. hirsutissima.* Prof. Webster collected specimens of *Panopeus* of the two forms described as *sayi* and *texanus*, but I can find no constant character to separate them; the coloration of the hand and presence or absence of the sub-hepatic tubercle certainly are not sufficient characters. A comparison of the young of *Hepatus decorus* with *H. tuberculatus* Saussure, as suggested by Stimpson, reveals the fact that the two species are distinct. A new species of *Lithadia* (*L. lacunosa*), allied to *L. cariosa*, was found at Sarasota bay, Florida. It differs, however, from that species in the ornamentation of the carapace, which is covered with circular depressions like those on a lady's thimble. Among the Anomura were specimens from North Carolina and Florida of the curious *Euceramus prælongus* Stm., which resembles a *Hippa* in form, but is allied by its structure to the porcelain crabs. A new species of *Pisosoma* (*P. glabra*) comes from Key West. It differs from *P. rüsei* in the simple not bimarginate front. *Polyonyx macrochelis* and *Lepidops venusta* were found at Fort Macon, N. C., adding two species to the fauna of that locality in addition to those mentioned in my list (Proceedings Philadelphia Academy, 1878, pp. 316-330). Among the Macrura the most noticeable was a species of *Ogyris* (*O. alphærostris*) from Northampton county, Virginia (Eastern shore, Atlantic side.) This species differs from the only other known one, *O. orientalis*, in having a rostrum like that of *Alphæus heterochelis*, and the absence of a dorsal carina on the carapace. The eyes are slender and elongate, strikingly like those of Hippa. A peculiar interest attaches to this and certain other genera of Crustacea (*Tozeuma*, *Urocaris*, *Rhynchocyclus* and *Limulus*) from the fact that the known species inhabit the eastern coasts of the two continents, while the western shores have no representatives of these genera. A similar fact in geographical distribution has been noticed in the flora. Specimens of *Alphæus minus*, from

Florida, were the largest I have ever seen, one measuring forty-five millemetres in length.—*F. S. Kingsley.*

THE BELOSTOMA PISCIVORUS.—Having some stickle-backs in a jar of water I was surprised at finding one or two of them dead, though hardy. Soon afterwards, however, I saw a large water-bug (Belostoma) seize one of these fish, pierce it with its strong beak, and apparently suck the fish's blood.—*Henry Turner, Ithaca, N. Y.*

EARLY STAGES OF THE OYSTER.—Certain of the early stages of the oyster have been studied in Europe, but a complete history is much needed. Prof. W. K. Brooks is now engaged on this subject at Crisfield, Maryland, where he has established the Summer Zoölogical Laboratory of the Johns Hopkins University in connection with the U. S. Fish Commission. He had succeeded May 20th in artificially fertilizing the eggs, ascertaining that the process of segmentation occupied two hours, and that in six hours free-swimming ciliated embryos are produced.

THE MAIOD CRABS.[1]—Mr. Miers has given in this paper a revision of the families, sub-families and genera of this interesting group of Crustacea. The genera enumerated number 106, and are placed in four families, Inachidæ, Maiidæ, Pericerídæ and Parthenopidæ, founded on characters derived from the orbits and antennæ. The families as given by Dana in the Crustacea of the U. S. Exploring Expedition, were shown several years ago to be faulty, and in the present state of our knowledge of this group, the arrangement proposed is generally good, and will prove indispensable to the student. The pages of the NATURALIST are not the place for an extended examination of this system of classification, but it may not be out of place to notice a few of the points, errors and omissions of the paper. The generic name *Podonema* is preoccupied (as *Podinema*) in the Reptilia, and I would here propose the name *Coryrhynchus* in allusion to the hood-shaped rostrum; it includes three species from Florida, *rüsei*, *hypoglypha* and *lamelligera*. The genus *Oncinopus* DeHaan, for which Dana established a separate group, is assigned to the neighborhood of Irachus. The placing of *Chorinus* and *Macrocheira* in the same section hardly seems proper, nor does the separation of Schizophrys and Cyclax from the neighborhood of Mithrax and Mithraculus. The placing of Libinia and Cœlocerus in different families is, we think, hardly right. A character separating *Mithrax and Mithrachulus* which is not noticed in this paper is that in Mithrax the anterior margin of the meral joint of the external maxilliped is notched for the reception of the succeeding joints, while in Mithraculus it is entire. The generic

[1] *On the Classification of the Maiod Crustacea.* By EDWARD J. MIERS. (Journal of the Linnæan Society of London—Zoölogy. Vol. XIV, 1879.) Pages 634–673, pls. XII and XIII.

name *Microrhyncus* is preoccupied, and Alphonse Milne Edwards has proposed in its stead the name *Neorhyncus.*

THE ROCKY MOUNTAIN LOCUST IN NEW MEXICO.—During a recent trip to New Mexico to investigate the southern limits of the distribution of *Caloptenus spretus*, I was enabled to ascertain a number of new facts regarding the extreme southern limits of this species. According to Ex-governor W. F. Arny, of Santa Fé, small swarms of destructive locusts, supposed to be this species, have appeared at a point 140 miles south of Santa Fé. Heretofore the U. S. Entomological Commission had been unable to trace it south of Taos, N. M., where it was known to have been destructive in 1877. From Ex-governor Arny and several Mexicans and Pueblo Indians we obtained the following facts, which are of general interest. In 1868 the counties of Valentia and Bernalillo were troubled by locusts. They probably came from the north-west as they do generally, and without doubt breed in the eastern portions of Arizona lying west of Valentia county, N. M. In 1865 they were seen near Santa Fé, and the wheat crop of the Pueblo Indians of Pojuaque was totally destroyed by locusts which came from the north-west. In 1868 the same Pueblo was visited late in the season. In 1871 Santa Fé, and in 1874 Santa Fé and Rio Ariba counties, including several Pueblo Indian towns, were invaded. In 1873 Colfax county was visited, and a few appeared the next year. In 1877 Santa Fé and Taos counties were invaded. The swarms at Santa Fé came from the west or south-west, in July, and passed up into Rio Ariba and Taos counties, crossing into Costilla county, Colorado. From these facts it seems that the northern half of New Mexico, and probably Northern Arizona, are occasionally subject to invasions of locusts from Southern Colorado; but the flights are sporadic and local, and occur after the wheat crop has been mostly harvested. Whether on account of droughts or locusts, or from both causes, the Pueblo Indians have, like the Egyptians of old, been in the habit of laying up stores of wheat and corn two and three years in advance.—*A. S. Packard, Jr.*

ZOÖLOGICAL NOTES.—We take the following notes from late numbers of *Nature*: Dr. Fritz Müller has sent from Brazil a trichopterous insect belonging to the *Leptoceridæ*, remarkable on account of its showing, very distinctly, branchia such as have lately been discovered in the imago state of this group by Dr. Palmèn.——M. Jourdain has read a paper before the French Academy on the respiratory apparatus of *Ampullaria*, a fresh-water mollusk.——The muscles of crayfish have been studied from a physiological point of view by M. Richet, the muscles of the clam have a high degree of contractibility.——M. Sörensen, in his studies on the apparatus of sound in various South American fishes, finds that vibrations are communicated to the air of the

swimming bladder.——The fauna of the Solomon islands has been discussed by Mr. E. P. Ramsay, several new birds being described; 120 mammals and about fifty species of insects were collected for the Australian Museum, of which Mr. Ramsay is the collector.——The fossil head of a *Rhinoceros ticorhinus* has been found in Siberia in a good state of preservation.——Another fossil mammoth has been found at Newburgh, N. Y.——The metamorphoses of the cantharides (*Lytta vesicatoria*) from the egg has been worked out by M. Lichtenstein, of Paris.——The body-cavity of sedentary Annelids has been studied by M. Cosmorici, and the anatomy of an Actinia, *Cerianthus membranaceus*, has been investigated by Von Heider.——The genus Squilla is now know to date as far back as the London clay, and Mr. Woodward, the discoverer of the fact, describes *Necroscilla wilsoni*, a supposed stomapod Crustacean from the middle coal measures, and a fossil king crab (*Limulus*) from the cretaceous formation of the Lebanon.——Collections of birds have lately been examined by London ornithologists, from the Argentine Republic and the United States of Columbia, the latter collection comprising 3500 specimens, representing 469 species.——A collection of land shells, of which ten or twelve are supposed to be new, collected by the late Dr. W. M. Gabb, in Costa Rica, has been reported on by Mr. G. F. Angas.——A young hippopotamus has lately died in captivity of trichinosis.——Immense swarms of butterflies have been witnessed at Le Mail and in Alsace, June 8th and 10th, and June 7th in Zurich.

ANTHROPOLOGY.[1]

ANTHROPOLOGICAL NEWS.—The first number of *Matériaux* for 1879 is one of unusual interest to the general reader. On page 22 is a report of a discussion before the Geological Society of London, on the mammoth in space and time. On page 31 is given a series of stone implements from Japan. On page 33 M. Maret presents the results of diggings in the grotto of Placard, Charent. Figure 18 represents a cresent-shaped implement from the horn of the reindeer, use undetermined. We beg to suggest that the object is drawn upside down, and that it resembles very closely the bone deadeyes used on Eskimo Kyaks for running lines; in other words it is the parent of our modern block for tackle. On page 46 we have the announcement of the meeting of the Congrès international d'Anthropologie et d'Archeólogie préhistorique at Lisbon, in 1880, and the programme of M. Daly's Course of Ethnology for 1880, at the School of Anthropology in Paris, as follows:

1. Les sciences anthropologiques. Définitions. L'ethnologie et l'ethnographie. Eléments statiques et dynamiques.

Sources de l'ethnologie. Anatomie et physiologie individuelle

[1] Edited by Prof. OTIS T. MASON, Columbian College, Washington, D. C.

et comparative. Caractères tirés de la coloration de la peau, des cheveux, et des yeux, du crane et du squelette. La taille. Langage et langues.

2. Sources de l'ethnologie (*suite*). Les voyages. L'histoire. Les traditions. Mythes et légendes. L'architecture. Les produits industriels.

Définitions relatives à l'espèce, à la race, aux variétés, aux familles, aux nationalités. Hérédité, Atavisme.

3. Distribution des races humaines. Eléments des classifications. Chap. x de la *Genèse*. Essais de classifications: Bernier, Linée, Buffon, Blumenbach, Virey, Cuvier, Lesson, Bory Saint-Vincent, Desmoulins, Latham, Isidore Geoffroy, Nott et Gliddon, d'Omallius d'Halloy, de Quatrefages, Huxley, Hæckel.

4. Classifications récentes: Triciologie. Crâniologie. Les types anthropologiques abstraits.

5. Ethnographie — Type éthiopique et ses dérivés. Races africaines. Races océaniennes.

6. Les négres d'Afrique. Sénégambie. Guinée. Gabon. Angola. Benguela.

7. Le Soudan. La Nubie. Le Haut-Nil. Les lacs. Résultats ethnologiques des récentes explorations de l'Afrique centrale. Ugandi, Niams-Niams et M'bouttous.—Akkas. Zulus.

8. Race bantou ou cafre. Bechuanas. Bassoutos. Makalolos Mozambique. Zanzibar. Somali, Gallas. Les Koï-Koïn et Hottentots. Avenir de la colonisation africaines.

9. Les colonies de nègres esclaves. Etats-Unis d'Amérique. Les Antilles. Le Brésil. Libéria. Inaptitude collective des nègres. Croisements des races noires africaines.

10. Races noires de l'Océanie. Negritos. Papous. Australiens. Races noires de l'Inde et de l'Indo-Chine. Les Weddahs. Les Mincopies.

11. Le type mongolique et ses dérivés. Branche turco-mongole. Les Mongols, Les Turcs. Les races boréales. Samoyèdes. Ostiaks. Kamtschadales. Aléoutiens.

12. Branches sinique et thibétaine. Races de la Chine et de l'Indo-Chine, du Thibet et de la Birmanie. Civilisation chinoise.

13. Branche malaisienne. Les Malais. Les Howas. Les Japonais. Aïnos. Carolins. Aptitudes civilisatrices.

14. Les Polynésiens.—Origine. Migration. Civilisation. Extinction prochaine.

15. Branche américaine. A. du Sud. Race ando-péruvienne. Quichuas et Aymaras. Les Antisiens. Les Araucans. Les Fuegiens. Race pampéenne. Les Patagons. Les Charruas. Race brazilio-guaranienne. Botocudos. Tupis, Mocovis. Mundurucus.

16. Races préhistorique de l'Amérique du Sud. Civilisation des Incas. Races indigènes de l'Amérique centrale et du Mexique. Civilisation mexicaine. Les Antilles. Etat présent des races de l'Amérique latine.

17. Amérique du Nord. Creeks et Cherokees. Comanches. Dacotahs et Sioux. Algonquins. Hurons. Iroquois. Californiens. Apaches. Yakis. Papagos. Athapascans, Chinooks. Nookta-Colombiens. Répartition et condition présente des indigènes de l'Amérique du Nord. Territoires indiens.

18. Les races françaises du Canada. Les races européennes aux Etats-Unis. Acclimatement. Fécondité respective. Effet général des croisements européens, nègres et indigènes. Les Chinois en Amérique.

19. Esquimaux et Kolosches.

20. Le type caucasique. Les Iraniens. Les Hindous. La légende aryenne. Populations dravidiennes de l'Inde. Les Castes. Brahmanisme, Mazdéisme et Bouddhisme. Afghans. Belouthes. Persans.

21. Races syro-arabes. Le Sémitisme. Les Phéniciens. Les Juifs. Les Chaldéens. Les Arabes. Les Abyssins.

22. Races caucasiennes. Géorgiens. Mingréliens. Arméniens.

23. Races méditeranéennes. Les Egyptiens. Civilisation nilotique. Pélasges et Hellènes. Etrusques. Races indigènes de l'Afrique septentrionale. Berbères. Touaregs. Kabyles.

24. Ethnologie de l'Algérie. Acclimatement respectif des immigrants. L'Algérie, la Sénégambie et le Gabon.

25. Races préhistoriques et proto-historiques de l'Europe. Races de Caustatt et de Cro-Magnou. Les Ibères. Les Ligures. Les Basques. Les Italiotes.

26. Les Goths. Les Cimbres. Les Germains. Invasions mongoliques. Celtes et Germains. Slaves.

27. Etat actuel de la domination ethnique. Colonisation. Population. Aptitude militaire.

28. Ethnologie.—Récapitulation. Tableaux comparatifs de la distribution des races humaines à diverses périodes. Les origines. Unité ou pluralité primitive du genre humain. Hypothèse dun' cantonnement primitif. Influence des milieux; altitude, température, climat, etc.

29. Théories diverses sur le transformisme et le spécifisme, de Maillet, Lamarck, Wallace, Darwin. Extinction des races inférieures.

30. Des croisements ethniques. Races croisées. Races mêlées. Leur valeur comparative. Résultats généraux et spéciaux du métissage. Mariages consanguins.

31. De la civilisation: Le langage. Geste et mimique. Chant. Langage articulé. La nourriture: plantes comestibles sauvages. La culture. Le feu. Préparation des aliments. Le sel. L'anthropophagie. Les armes. Les outils. Le développement de la civilisation est lié au perfectionnement des armes et des outils. La domestication des animaux. Le vêtement. Funérailles.

32. Transmission des idées. Le nombre. L'alphabet. L'écri-

ture. Le dessin. La gravure et la peinture. L'imprimerie. La sténographie. La musique. L'harmonie.

33. L'organisation sociale. La famille. Le mariage. Polyandrie. Polygamie. Position des femmes dans la société. Les Castes. La hiérarchie. La guerre. L'esclavage.

34. Mythologies et légendes. Religions. Philosophies. Conceptions diverses du Cosmos. Le fétichisme. Culte des pierres, des arbres, des animaux. Astrolâtrie. Chamanisme. Sacrifices humains. Polythéisme. Monothéisme. Rationalisme. Athéisme. Positivisme. Répartition ethnique des croyances religieuses. Atavisme religieux.

35. Mutilations et déformations ethniques. Déformations du crâne, du pied, des oreilles, du nez, de la bouche. Eunuchisme. Ovariotomie esthétique. La circoncision. Colorations. Ornamentation.

36. Les migrations. Lois générales de l'accroissement et du décroissement de la population. Epidémies. Pathologie comparative des races. Famines. Alimentation comparée des races. Rendement musculaire.

37. Causes générales des migrations. La conquête. La chasse. La pêche. L'épuisement du sol. La navigation. Phéniciens. Grecs. Arabes. Commerce des esclaves. Métaux précieux. Excédant de population. Evénements politiques. Colonies pénitentiaires.

38. Aptitude ou inaptitude des races à la civilisation. Relations du milieu géographique avec le développement. Fertilité du sol. Rivières, îles et continents. Civilisations interrompues. Civilisations disparues. Emprunts réciproques.

39. Chronologie comparative. Conditions de la perpétuité de la civilisation. Création du droit. Evolution des idées morales, esthétiques et scientifiques. Théorie ethnologique du progrès. Théorie physiologie.

40. Portée utilitaire de l'ethnologie. Conflits modernes des races. Colonisation. Migrations futures. Prévisions ethnologiques.

GEOLOGY AND PALÆONTOLOGY.

A Remarkable New Genus of Giant Sloths.[1]—This memoir describes the skull of a new species of Megatherium-like animal, which Dr. Reinhardt has called *Grypotherium darwinii*, from the pleistocene of the Argentine Republic, and which has been presented to the Museum of Zoölogy of the University of Copenhagen by Dr. V. Lausen, together with a large number of the remains of other animals from the same place. The skull of this Megatheroid is of great interest, for whilst it is unmistakably to be referred to that group of animals, it presents a singularity not found in any other recent or fossil sloth.

[1] *Beskrivelse af Hovedskallen af et Kæmpedovendyr, Grypotherium darwinii, fra La-plata-Landenes plejstocene Dannelser.* Af. J. Reinhardt. (Ext. Videns. Sels. Skr. 5te Raekke, Naturvidens. og Math. Afd. xii, 4. 4to, pls. ii.) Kjöbenhavn, 1879.

The skull is that of an old animal, as the sutures are almost entirely obliterated. Its length is .610 m. (a little more than two feet), which would make the creature, when alive, intermediate in size between *Megatherium americanum* and *Mylodon robustus*, and therefore belonged to one of the largest forms of the family yet discovered. The most remarkable feature of the cranium, and one which is without a parallel in the family, and hence at once distinguishing it from all allied forms, is the singular structure of the muzzle. The intermaxillary bones are completely coössified (owing, perhaps, partly to the age of the animal), and rise vertically upon the median line in the form of a buttressed bony arch to unite above with the anterior extremity of the nasal bones, which extend forwards beyond the anterior extremities of the maxillaries, resulting in a structure remotely resembling the same parts in *Rhinoceros tichorinus*, and in the absence of an osseous nasal septum, more notably that of *R. merckii*, in which the bony nasal partition is only partially ossified. There is abundant evidence to show that this arch is not a part of the nasals prolonged forward, since there is a suture separating the latter from the intermaxillaries proper. The structure, however, in this animal is not nearly as strong as in *R. merckii*, an explanation of the strength of whose nasal bones is clearly to be sought in the fact that these were surmounted by immense horns which it probably used with great effect; as to whether or not the nasals were armed in *Grypotherium*, there is nothing to indicate, at present at least, that they supported a weapon of any sort.

The presence of the intermaxillary arch undoubtedly entitles Prof. Reinhardt's species to generic rank, in fact there can be little doubt of the propriety of dividing the *Megatheriidæ* provisionally into two new groups, the extinct genera *Mylodon*, *Scelidotherium*, *Megatherium*, *Megalonyx*, *Cœlodon*, being forms typical of—

a. Aphelorhinæ; with unspecialized intermaxillaries.

b. Diarhinæ; with intermaxillaries vertically produced and joined by suture to the anterior extremity of the nasals, and dividing the external nares as in *Grypotherium*.

The intermaxillary arch dividing the external nares, but without an osseous nareal septum, recalls the arrangement of the bones of the muzzle of certain lizards, more particularly those of *Iguana*.

The tooth formulæ of some of the extinct genera may be compared as follows:

Scelidotherium and *Mylodon*.....molars $\frac{5-5}{4-4}$

Grypotherium..... " $\frac{4-4}{4-4}$

Cœlodon..... " $\frac{4-1}{3-3}$

forming a series which exhibits very nicely a process of gradual reduction in the number of teeth.—*J. A. Ryder.*

A NEW SPECIES OF CŒLODON.—Prof. Reinhardt's contributions to our knowledge of the poorly known genus *Cœlodon* established in 1839 by Dr. Lund for the reception of a Megatheroid, the remains of which were obtained by the latter author in the bone caves of Brazil, are also noteworthy. The memoir[1] deals with the remains brought by Dr. Lund to Copenhagen, but not fully described and figured by him. The skull in the present paper is well represented, and valuable figures are given of the feet of *Cœlodon escrivanensis*, based on the remains of the young individual found in the last cavern, la Lapa de Escrivania, which Dr. Lund explored in 1844, whilst the name *C. maquinensis* Lund, is retained for the species represented by teeth found in la Lapa nova, Maquiné by that explorer in 1835. The *C. escrivanensis* was about the size of the large South American ant-eater (*Myrmecophaga jubata*), and in the opinion of Dr. Reinhardt was most nearly allied to *Mylodon*, and in some respects to the existing arboreal *Cholœpus*. Its habits, the same authority thinks, were arboreal, and he looks forward with much interest to the discovery of an extinct type which seems to us dimly shadowed forth in *Cœlodon*, and which will connect the fossil Megatheroids with the existing species of sloths. To us there is much evidence to show that the history of these animals—their succession in time and their descent—will yet be as completely worked out as that of the horse, dog and camel.—*J. A. Ryder.*

GEOGRAPHY AND TRAVELS.[2]

AFRICAN EXPLORATION.—Dr. Rohlfs writes from Djâlo (south-east of the Sella or Zeila oasis), on the 8th of April last, that he left Sokna on the 11th of March. Up to that point the traveler passed over a new route, partly through a desert country, and also through two hitherto unknown oases, Abu-Naïn and Djebbena. This region abounds in fossils of every kind, Ammonites, Echinidæ and others. "There is probably no other district in the world which is equally rich in its extinct marine fauna." Dr. Stöcker has sent home an accurate topographical survey of the Djofra oases on the scale of 1 : 100,000. These three oases, Sokna, Hon and Uadan, are bounded by ranges of hills to the north and south—the highest peak is Gannassa, 2000 feet above the sea-level. Owing to the fanaticism of the natives, Dr. Rohlfs was badly received at Djâlo, and has been unable to procure a guide on account of the unfriendliness of the Bengasine government. Dr. Stöcker has returned to Bengasi to try to favorably

[1] *Kæmpedovendyr Slægten Cœlodon.* Af J. REINHARDT. (4to, p. 257–349, pls. 7. Ext. Videns. Selsk. Skr. 5te Raekke, Naturvidensk. og Mathem. Afd. XII, 3.) Copenhagen, 1878.

[2] Edited by ELLIS H. YARNALL, Philadelphia.

influence the rulers of the country and enable the expedition to proceed to Kufra, the next oasis in their journey to Wadai.

Mr. Donald Mackenzie has established a station at Cape Juby on the north-west coast of the continent, and made a treaty with a powerful native chief, by means of which it is hoped a large and important trade with North-central Africa will be opened up.

M. de Semellé has now returned to France, and states that he followed the course of the Niger from Omtcha as far as Boussa, a distance of 300 miles, and the Benué as far as Oku (?). He has collected much information on the products of the country, and concerning the history and traditions of the people. Daily meterological observations were taken.

M. Soleillet has also returned home, and in a recent address speaks highly of the intelligence and peaceable character of the Sultan and population of Sego. The Niger at Sego, 2000 miles from its mouth, is 300 yards wide.

The Rev. S. I. Comber, of the Baptist Missionary Society (English), has left England to found a station at San Salvador, situated about 100 miles south of the Congo and 200 from the coast. He hopes ultimately to reach Stanley Pool above the falls of the Congo, and launch there a small steamer which is to be taken up in sections. The Royal Geographical Society has supplied him with instruments.

Dr. Buchner, one of the German African Society explorers, has been detained by the rainy season at Cassange, on the Quango, before going on to the capital of Muata Yanvo's kingdom.

Maj. Mechow, another member of this expedition, will attempt to descend the Quango river from Cassange until it joins the Congo, where Stanley identifies it with the Ibari Nkutu.

Maj. Serpa Pinto, on his arrival in Lisbon, delivered a lecture on his recent journey from Benguela to Natal. This address has been fully reported in the daily press of England and America, but being unfortunately very vague and rambling in character, we are glad to quote from the London *Athenæum* (July 19, 1879) the following notice of his work as explained by him very recently to a company gathered at the house of the president of the R. G. S., in London: "The new ground traversed by Maj. Pinto is comprised between Bihé, in the interior of Benguela, and a place called Lialué, in the 'Barotse valley,' passed by Livingstone on his journey northward along the Zambesi towards St. Paulo de Loanda. Thus defined, the new country which the Portuguese explorer has opened up, is about five hundred miles broad from north-west to south-east. The blank space is traversed on Livingstone's map by a number of rivers set down from native report, and the names have turned out generally to be correct, although the courses of the rivers are wrongly given. The great merit of Maj. Pinto's exploration lies in the accurate definition of these rivers, and the fixing of all important points by astronomi-

cal observation. Arrived on the Upper Zambesi, his route led him along regions previously made known by Livingstone and other travelers. Maj. Pinto, however, made excursions near the confluence of the Chobé to ascertain the true hydrology of the region before striking south-eastward. He then made for Soshong, the capital of the Bechuana country, and crossed the little known westerly portion of the Transvaal on his way to Pretoria and Natal, continuing his survey as he went, and adding most materially to an accurate knowledge of the geography of the less known districts."

"As geographical results of the highest importance must be mentioned first his longitudes. Maj. Serpa Pinto performed the feat of carrying three chronometers, one of which, by Dent, kept excellent time across the continent. Their indications were checked by astronomical observations, including the transit of Mercury, eclipses and occultations, which have been proved exact; and thus there are no grounds for doubting the remarkable conclusion which he draws, that Soshong is placed on our maps more than a degree *west* of its true position—a conclusion which necessitates the shifting of the Limpopo a degree to the east and narrowing our territory in the Transvaal to a corresponding amount."

"Next in importance is the light he has thrown on the topography and physical geography of the region along the southern border of the Benguela highlands. Lieut. Cameron, who traversed these highlands on his journey from east to west, established the fact that the succession of terrace-formed coast ranges of Western Africa here broadens out into a lofty plateau. Pinto devoted much of his time and attention to this interesting region. He visited the sources of many of the rivers rising on this water shed, traced and mapped them; and afterwards, part of the courses of two of them, which flow south and south-west towards the lower lying region bordering the Kalahari desert. On the Benguela plateau, at an elevation of 5800 feet, is situated the central native town of Bihé, peopled by a race of Boer traders and travelers, parties of whom annually traverse the whole western interior. A little west of this, within the space of a few yards, rise four great streams which flow respectively north-west and south-west to the Indian ocean, east to the Zambesi and south to Lake Ngami. Pinto's journey southward and eastward from Bihé led him to the upper waters of the Cubango and its tributaries, and the Quando. The Cubango (visited in its lower course by Andersson and called by him the Okavango) he satisfied himself has no connection with any other stream, and discharges its waters in the inland basin of Lake Ngami. But the Quando, a much less known and far more important stream, after gathering the drainage of numerous large tributaries, flows for several hundred miles as a navigable river and enters the Zambesi, its lower course

being the stream made known by Livingstone under the erroneous name of Chobé.

"Maj. Pinto did not descend these rivers for any great distance, but struck across their upper waters. He had by that time exhausted his means and was reduced to the verge of starvation in a district of swamps inhabited by a light-colored race of savages allied to the Bushmen. He consequently made for the Zambesi by the nearest route, and eventually succeeded in struggling through to the less barbarous settlements further south. He has submitted all his maps and astronomical observations, and his well kept barometrical register to the inspection of competent judges in London."

The other division of the Portuguese Expedition, under Messrs. Capello and Ivens, arrived at Cassange in December, 1878. Since leaving Bihé in November, 1877, they have explored a part of the river Quango. When last heard from (April 5, 1879) they were on the margin of the river Lucala, examining the country traversed by the Cubango. They had already explored that river from its source to 8° S. lat.

MICROSCOPY.[1]

CONTAGION AND THE GERM THEORY.—One of the best of the "American Health Primers," now in course of publication by Lindsay & Blakiston, of Philadelphia, is the little treatise upon "Long Life and How to Reach it," by Dr. J. G. Richardson. As might be expected, from the name of the author, those parts of the subject which have been fields for microscopical work, are treated with marked interest and ability. The germ theory of disease, in which the author seems to have become an earnest believer, is explained in a very simple and plausible manner, and is made the text for much sensible advice as to the means of avoiding contagious diseases, including those which are communicated by public drinking cups and toys, such as whistles and toy balloons, which are touched to the lips after having been similarly used by other people. Very valuable, too, are the conclusions in regard to purifying and disinfecting infected articles or localities; and the folly is once more pointed out, which it seems as if people never would learn, of believing a place to be disinfected because it has been made to smell badly of some reputed disinfectant.

THE MICROSCOPE IN ENTOMOLOGY.—The illustrated paper on the anatomy of *Amblychila cylindriformis*, by Mr. Carl F. Grissler, of Brooklyn, published in recent numbers of *Psyche*, is so full of philosophical spirit and of fine microscopical work, that it will interest many who are not entomologists and to whom the Cicindelidæ would be new acquaintances. This thorough and system-

[1] This department is edited by Dr. R. H. WARD, Troy, N. Y.

atic study, with its fine plate drawn on stone by the author himself, is a good example of how the microscope ought to be used. Microscopists will be similarly interested in the study of the structure of the tongue of the honey bee, by Prof. J. D. Hyatt, in the last, July, number of the *Amer. Quar. Mic. Journal.*

MANDIBLES OF ANTS WORN BLUNT BY USE.—"Much interest has lately been developed, in the Cambridge Entomological Club and in the Entomological Section of the Boston Society of Natural History, by discussions which owe their origin to the statement published by Rev. H. C. McCook, that the mandibles of ants are worn off and become blunted by the labor which they perform. It has been thought that Mr. McCook was mistaken, that the chitin of the mouth parts of insects remained as it had been upon emergence from the chrysalis, and that the forms of mandibles observed by Mr. McCook were monstrosities. In confirmation of the wearing away of mandibles, Mr. E. P. Austin exhibited, at the last meeting of the Entomological Section of the Boston Society of Natural History, nearly a hundred specimens of *Pasimachus*, in which all the fresh, bright-looking specimens had perfectly-shaped sharp mandibles, while those specimens which were old and worn in general appearance presented every gradation of bluntness of the mandibles. Communications on this subject, based on observation, would be acceptable to the Cambridge Entomological Club."—*Psyche.*

AMERICAN QUARTERLY MICROSCOPICAL JOURNAL.—For the first time we are inclined to find fault with this new journal. The July number contains several good natural history articles and a variety of interesting notes on aperture, illumination, &c. The portion with which everybody will be disappointed is the announcement that its publication will cease with the present number. This will leave us once more without an American periodical devoted to the publication of elaborate memoirs upon microscopical subjects. The journal has already acquired a character and name too valuable to be lost, and it is to be hoped that the editor and publishers will be induced to reconsider their decision to abandon the enterprise.

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SCIENTIFIC NEWS.

— We take pride and pleasure in drawing attention to the appreciative manner in which British naturalists testify to the nature of work recently done in this country in ornithological bibliography, and trust that the desired results may be brought about.

Memorial to Elliott Coues, Esquire, Assistant Surgeon United States Army.

We, the undersigned, beg leave to express our high appreciation of the "Bibliographical Appendix" to your work, "Birds of the Colorado Valley," being No. 11 of the Miscellaneous Publications of the United States Geological Survey of the Territories, under the charge of Dr. Hayden. And at the same time we wish to place on record our gratitude to that gentleman and to the authorities of the department to which you are attached, for the liberality they have shown in granting you permission to stay at Washington for the completion of this and other important works upon which you have now been so long and so usefully engaged.

The want of indexes to the ever increasing mass of zoölogical literature has long been felt by all workers in every department of that science; but the enormous labor of compilation has hitherto deterred many from undertaking a task so appalling. It is with no small satisfaction that we recognize your readiness to devote yourself to work of this nature. Moreover, we feel justified in hoping that should the installment now published in the volume above named be enlarged in a similar manner so as to include a complete bibliography of ornithology, this branch of science will possess an index to its writings, perhaps more complete as to its scope and contents than any kindred subject of similar extent.

An undertaking of this sort is beset with formidable difficulties; not only is its extent enormous and the works relating to the subject are widely scattered through many libraries, public and private, but the qualifications of a good bibliographer are not easily to be found united in one person. His application and industry must be untiring, and he must be thoroughly conversant with the art of bibliography. In addition to these requirements, in a case like the present, an equally thorough knowledge of the subject under consideration is indispensable. You happily combine all these qualifications; your industry has long been approved, your knowledge of books is evident from what you have now put before us, your knowledge of ornithology has long been known to us. We can well believe that the libraries of your own country are better stored than any others with works relating to the ornithology of North America, and that, therefore, the "List of Faunal Publications relating to North American Ornithology" could be nowhere better prepared than in Washington; but when the ornithological literature of the whole world has to be examined, it seems to us almost indispensable that the older libraries of Europe, and especially of England, France, Italy, Germany and Holland should be consulted if one of the chief merits of your work is to be maintained, viz: The consultation at first hand by yourself of every work mentioned therein.

This brings us to one of the chief objects of this memorial,

which is to express our sincere hope that time and means will be found you to prosecute in Europe the great undertaking you have commenced so well, and bring it to a successful conclusion. Should the authorities who preside over the department to which you belong—and especially the Surgeon-General of the United States Army—who have hitherto so liberally granted you facilities for the scientific work you have performed, be disposed to furnish you with these means of perfecting your undertaking, we are convinced that it will reflect great credit to them and the country to which you belong. We on our part, so far as England is concerned, are ready not only to welcome a brother ornithologist, but also to render you every assistance in our power.

[Signed.]

W. H. Flower, F.R.S., etc., President of the Zoölogical Society of London.
T. H. Huxley, Sec. R.S.
Charles Darwin, F.R.S.
St. Geo. Mivart, F.R.S., Sec. L.S.
Alfred R. Wallace.
A. Günther, F.R.S., Keeper of the Department of Zoölogy, British Museum.
Philip Lutley Sclater, M.A., Ph.Dr., F.R.S., Secretary to the Zoölogical Society of London.
Alfred Newton, F.R.S., V.P.Z.S., Prof. of Zoölogy in the University of Cambridge.
H. B. Tristram, F.R.S.
Osbert Salvin, M.A., F.R.S., Editor of *The Ibis*.
F. Du Cane Godman, Secretary of the British Ornithologists' Union; and twenty-six others.

— Recent arrivals at the Philadelphia Zoölogical Garden: 1 English blackbird (*Turdus merula*); 1 Angora goat (*Capra hircus* var.); 4 barn owls (*Strix flamea americana*); 1 sandhill crane (*Grus canadensis*); 1 ring-necked snake (*Diadophis punctatus*); 2 Virginia deer, twins (*Cervus virginianus*), born in the garden; 2 electrical eels (*Gymnotus electricus*), South America; 2 red-crested cardinals (*Paroaria cucullata*), South America; 14 lizards (*Sceloporus undulatus*); 2 mule deer, twins (*Cervus macrotis*), and 1 fallow deer (*Dama vulgaris*), born in the garden; 7 mandarin ducks (*Aix galericulata*), China; 1 rose-crested cockatoo (*Cacatua moluccensis*); 5 banded rattlesnakes (*Crotalus horridus*); 1 wild cat (*Lynx rufus*); 78 finches of the following species—cutthroat finch (*Amadina fasciata*), spotted munia (*Munia undulata*), Maja finch (*Munia maja*), black-headed finch (*Munia malacca*), sharp-tailed finch (*Munia acuticauda*), amaduvade finch (*Estrelda amaduva*), orange-cheeked finch (*Estrelda melpoda*), bicolored finch (*Amadina bicolor*); 1 elk (*Cervus canadensis*), born in the garden; 2 short-eared owls (*Brachyotus palustris*); 13 opossums (*Didelphys*

virginiana), born in the garden; 2 collared peccaries (*Dicotyles torquatus*), born in the garden; 1 common gannet (*Sula bassana*); 1 pine snake (*Pityophis melanoleucus*).

— Phosphorescence appears in the flesh of marine animals along with a gelatinous substance which is formed. With the microscope (according to MM. Bancel and Husson) one finds two kinds of germs; at the surface-cells which no doubt produce this mucous fermentation, and in the mucus very small bacteria. The cells are thought to act like plants, decomposing carbonic acid of the air by day, fixing the carbon and liberating the oxygen in the liquid. By night they liberate carbonic acid, and the germ then lives and causes destruction of the matters round it, condensing oxygen and producing carbonized and phosphorized hydrogen. The hydrogenized products being burnt as they are produced, cause the phosphorescence. The author considers the phosphorescence of the lobster due to a fermentation of the kind referred to.

Apropos of phosphorescence, M. Nuesch records in a recent number of the *Journal de Pharmacie*, some curious observations regarding luminous bacteria in fresh meat. Some pork cutlets he found illuminated his kitchen so that he could read the time on his watch. The butcher who sent the meat told him the phosphorescence was first observed in a cellar where he kept scraps for making sausages. By degrees all his meat became phosphorescent, and fresh meat from distant towns got into the same state. On scratching the surface or wiping it vigorously, the phosphorescence disappears for a time; and the butcher wiped carefully the meat he sent out. All parts of the animal, except the blood, acquired the phenomenon over their whole surface. The meat must be *fresh;* when it ceases to be so, the phosphorescence ceases, and *Bacterium termo* appear. None of the customers had been incommoded. It was remarked that if a small trace of the phosphorescent matter were put at any point on the flesh, of cats, rabbits, &c., the phosphorescence gradually spread out from the center, and in three or four days covered the piece; it disappeared generally on the sixth or seventh day. Cooked meat did not present the phenomenon, but it could be had in a weak manner from cooked albumen or potatoes. No other butcher shop in the place was affected. The author is uncertain whether to attribute the complete disappearance of the phenomenon to the higher temperature of the season, or to phenic acid, or to fumigation with chlorine.—*English Mechanic.*

— In "Notes on *Pterygocera annarice*," by Carl Bovallius (Kgl. Svenska Vet. Akademien Handlingar, Bd. 4, No. 8, 1878), we have a very full account of this interesting form of Amphipod, on which the author bases a new sub-family. The author also gives

in a foot-note a short account of Martinus Slabber, the original describer of the species, which we copy:

"Martinus Slabber was born in 1741, probably at Middleburg. In 1767 we find him elected a member of the Hollandische Maatschappye der Wetenschappen. He was then called 'Bailleuw en Secretaris te Baarland en Bakendorp, en Secretaris te Oudeland.' In 1769 he was a member of 'Zeeuwsch Genootschap der Wetenschappen te Vliessingen. In 1793 keeping the above named charge, he seems to have removed to the town Goës, where we find him in 1807 as 'Raad der Stadt.' He died in Gravenpolden in 1835, aged 94 years. All these places are situated on the isle of Walcheren."

A list of his published works, six in number, is also given. Slabber, we would here note, was the first to figure the zoea of Crustacea.--*J. S. K.*

— Locusts are reported as doing much damage in Southern Russia in June; also swarms of locusts appeared in North-west India, by advices received in London, in April. Swarms of locusts have likewise recently appeared in Armenia; news from Elizabethpol states that both the banks of the river Kur were completely covered with the insects as far as Terter on the one bank, and as far as Akstafa on the other. All vegetation is devastated.

— In a posthumous paper by Frederic Smith it is stated that the general aspect of the Hymenopterous fauna of the Hawaiian islands is North American, with admixture of a few South American forms. The ants are most diverse in character, some being cosmopolitan in range. The house ant of Madeira is common, and the little European ant (*Ponera contracta*) also occurs there.

— The well known British entomologist, Frederick Smith, assistant keeper of the Zoölogical Department, British Museum, London, died Frebuary 16, aged 72.

— Prof. Lawrence Smith has been elected by the French Academy, correspondent in mineralogy, in room of the late Sir Charles Lyell.

— Dr. Page, Prof. of Geology at Durham, died at his residence, Newcastle-on-Tyne, lately. Prof. Page was a voluminous writer on geology and the physical sciences. He was long connected with Messrs. Chambers, of Edinburgh, and many years ago his name was a good deal associated with the scientific basis of the well-known book, "The Vestiges of the Natural History of Creation."

— Prof. Huxley has lately avowed his belief in the fungoid origin of certain diseases, as may be judged by the following extract from a recent address reported in the *English Mechanic*: "The fungi were the greatest destroyers of useless matter. Nature did her best to get rid of this matter. Death was said to

be one of the causes of putrefaction, but this was not quite true, and it would be more correct to say that life was the cause of putrefaction. If they took proper precautions to keep away from any dead body the organisms he had mentioned, it would not putrefy, and the sole cause of that most disagreeable change called putrefaction was the introduction of a particular form of life more analogous to the fungi than anything else, known as Bacteria. It was only lately that they had known much about them. The *Bacterium termo* was not more than a 30,000th part of an inch. If they took a small portion of fluid of putrefying matter they would find millions of them in every drop, darting about as if they were fishes. They multiplied with enormous rapidity, and after a certain period of activity passed into a period of rest, and afterwards the protoplasmic substance broke up, and each spore gave rise to a *Bacillus subtilis* again. Their rate of multiplication was so excessively rapid that it needed only one of these Bacilli to get into a liquid, and in the course of a couple of days the whole of that liquid would be visibly turbid in consequence of the multiplicity of the Bacteria to an extent which no arithmetic could express. The importance of these bodies was that they exerted a fermentative influence, and they did for the fluid what yeast and barm did. It was this fermentative product which gave rise to putrefaction, and if they took such precautions as would keep out the bacteria, a dead body would remain intact for an indefinite period. It was on this principle that meats were preserved for an indefinite period by being partly boiled and then hermetically sealed in tins so as to preclude the air getting in. If they considered what would happen if all the animals that died remained where they died until they dried up, they would see what an important part these Bacteria played, and if they could all be gathered together they would make more than all the rest of the animal and vegetable kingdom. But they had a great significance which it was important they should all understand. In France there was an enormous silk industry, but it sometimes was almost annihilated through the death of the silk-worms, and that was almost always indisputably caused by a fungus. A disease which had all the characteristics of an infectious epidemic resulted in consequence of the germs of the fungi being introduced into the caterpillar, and each one infected became a source of infection, which spread in the same way as infectious diseases were propagated. There was a splenetic fever known in some countries which killed many cattle, and it had been made out that it was caused by these Bacteria. If they inoculated a healthy animal with it, they at once had the symptoms of the splenetic fever. A new disease had been investigated which was very fatal to pigs, which sometimes became epidemic, and which was caused by Bacillus. In vaccine lymph and smallpox there were small minute bodies, and it was found that in these the infection resided, so that they were coming to this conclusion, that the whole of our

great epidemics were of the same nature, and if that were correct there could be few forms of life of more importance than those in the limits of the visible, which he had been describing."

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PROCEEDINGS OF SCIENTIFIC SOCIETIES.

APPALACHIAN MOUNTAIN CLUB, June 11.—Mr. C. W. Folsom read a paper entitled Notes on elementary surveying for amateurs. Mr. J. B. Henck, Jr., exhibited and described several forms of pedometer, including the five dollar American pedometer.

July 9.—The seventh field meeting convened at the Crawford House, N. H. The meeting was called to order by Prof. William H. Niles, Cambridge, Mass., president of the club. A paper was read by Prof. Charles E. Fay, of Boston, on Mount Carrigan, to the summit of which a path had just been completed by the club. (Members of the club conducted a party from the Institute of Instruction to the summit of Mount Carrigan July 10th.) Prof. Hitchcock, of Dartmouth College, spoke on the geology of the White Mountain Notch. F. V. Hayden, U. S. geologist, spoke on the White and Rocky mountains, and Prof. F. W. Clark, of Cincinnati, on North Carolina and Tennessee mountains and scenery.

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SELECTED ARTICLES IN SCIENTIFIC SERIALS.

AMERICAN JOURNAL OF SCIENCE AND ARTS.— July. Silurian formations in Central Virginia, by J. L. Campbell. Extinct volcanoes about Lake Mono and their relations to the glacial drift, by J. LeConte. (These volcanoes were active since and probably before the glacial period.) Recent additions to the marine fauna of the eastern coast of North America, by A. E. Verrill. Notice of a new Jurassic mammal, by O. C. Marsh. On the Hudson river age of the Taconic schists, by J. D. Dana.

PSYCHE. — July. Pupation of the Nymphalidæ, by W. H. Patton.

ZOOLOGISCHER ANZEIGER.—June 9. Keller on the embryology of the sponges (Chalina). Benecke on the maturation and fertilization of the eggs of the bats.

THE GEOLOGICAL MAGAZINE.—June, On recently discovered teeth of the musk ox (*Ovibos moschatus*) at Craybow, Kent, by W. Davies. The Glacial period in Eastern America, by C. H. Hitchcock. The Till in New England, by W. Upham.

CANADIAN NATURALIST.—June 23. A Canadian Pterygotus, by J. W. Dawson. Mœbius on *Eozoön canadense*, by J. W. Dawson.